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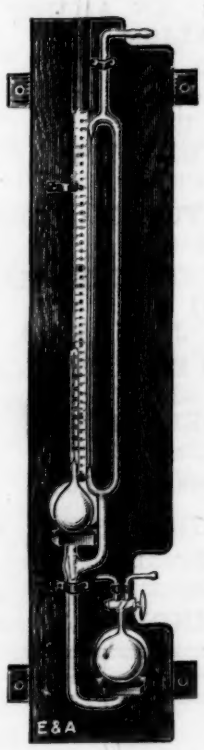

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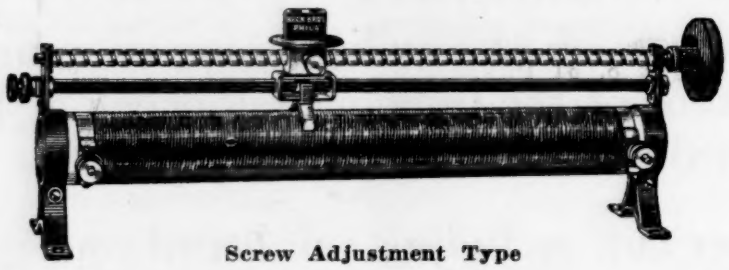

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MEDICINE AND THE EVOLUTION OF SOCIETY[1]

IN its inception medicine represented the effort to palliate or cure ills already fastened upon individuals. With advancing understanding of value in social machinery there came naturally a development of interest on the part of the community in organizing itself to guard against disease or ill health, and in some measure in protecting itself against the individual. As in practically every form of scientifically planned activity for human benefit, medicine rapidly passed beyond the stage of mere palliation, correction or warding off evils, and became a positive or constructive agency building along new lines where once it sought only to repair or to protect.

Methods and rate of advance in evolution of medicine have varied greatly. The development of a desire to carry proficiency to perfection has produced an art. A permanent cast of open-mindedness has produced research.

Achievements of the science and art of medicine which have made possible modern wonders of antiseptic surgery and of immunization are now followed by efforts aimed toward complete elimination of diseases, as in the epoch-making activity of the Rockefeller Foundation in eradication of yellow fever.

In addition to correction, cure and prevention of disease, much constructive work has been done in bringing our physical condition, at various stages in development of the individual, to a level of effectiveness not known in earlier generations. Research on the eye, coupled with utilization of lenses, gives continuing effective sight. Increase in number of deaths from troubles of the heart and of the circulatory system in general, which seem to come with higher average age, stimulated study of these organs in their relation to physiology of the whole body, with results which may give us new lease of life.

Although its effort must always be directed largely to curative and preventive functions, medicine is now in the distinctly constructive stage.

Discussion of questions touching evolution of society implies justification for the assumption that society will continue to exhibit changes of the nature

[1] Read at the public exercises of dedication for the School of Medicine and Dentistry of the University of Rochester, October 25, 1926.

which we call evolution or advance. The human problem is one of many aspects, and I am presuming to examine it, to some extent, from the point of view of one reviewing history in its longer reaches.

We may admit the almost incomprehensibly difficult nature of any study that concerns itself with the future. I am fully aware of the danger of such ventures and that the statement concerning the prophet being "not without honor, save in his own country" should, to wise men, act as a deterrent. At the same time it is clear that for guidance in many of our greatest practical problems there are no aspects of thought more clearly needing cultivation and organization at this time than just those key questions relating to the trend of human development.

To-day as never before the scientific world seems distinctly interested in the future of society. Exceptional stimulation of patriotism during the great war gave us a high expression of solidarity and effective human organization. The post-war period in scientific philosophy carried us to the other extreme, and was one in which literature was filled with reflections of certain aspects of social organization indicating incipient decline or degeneration. A decade of sustained peace has permitted products of constructive thought to accumulate. To-day, with organization of humanity reaching a stage of complexity not heretofore known, it is natural that close attention be given to examination of social movement or evolution and to search for evidence as to the direction in which it may be expected to extend.

The present status of thought concerning broader aspects of human relations is also in part due to a distinct tendency toward emphasis on fundamental philosophic concepts and toward viewing each subject in the light of its most comprehensive expression. The intensive effort expended by the specialist is seen to be of importance both because of the individual facts it furnishes for building and because the particular line of effort which it extends gives another kind of view of the whole structure of knowledge.

The expert in study of spectral lines in astronomy attains a skill of interpretation that enables him to pass instant judgment on questions concerning temperatures or movement or other conditions existing in vastly distant solar or stellar sources of the spectra. The expert on variation in mice or jimson weeds may fail to understand the distinctions separating types of spectral lines; just as the differences among mice or jimson weeds, about which he talks with such assurance, may be absolutely non-existent so far as the immediate powers of perception of the physicist or astronomer are concerned.

The significance of the situation in science of to-day is expressed in the fact that the astronomer is using the spectral line to give essential data relating to conditions indicating distance or states of motion, and other factors which concern the nature and structure of the universe. And the jimson weed expert is not so much concerned with the species or varieties of the genus Datura as he is with the principles which tell us something of the operation of reproduction, variation and evolution.

Our tendency to broader generalization and more distinctly philosophic consideration of fundamental law is itself in some measure due to a tremendous widening and deepening of the realms of space and time and movement in which our thought ranges. This expansion has tended more and more to bring about contact or overlap or connection between aspects of nature which once seemed unrelated.

In space relations, astronomy now carries its limits out so far that our solar system becomes only a speck in a vast galaxy of stars with dimensions measured in hundreds of thousands of units each representing trillions of miles. Our milky way or galaxy, with these dimensions, is seen as only a speck in a universe of galaxies of which the farthest fade out gradually to a region where they vanish, not because space ends or the world of universes terminates, but because the one telescope by which we see these remote specks has reached the limit of its power of definition.

In time relations, geology shows us the actual sweep of ages in records that hold the epochs of the past before us in order of their being. Here we see time stretched backward from our day through periods measured in hundreds of millions to billions of years—and yet the reality and meaning of that time, and of what happened in it, is like the present. Paleontology presents the moving current of life streaming through geological eons, with its marvelous history of development leading through lower forms up to man and on by stages of human progress to attainments of present culture.

As our world of scientific thought broadens and shows more and more clearly the connection between remoteness in space and time and our place in the living present, it is not possible to avoid the formulation of laws which cover also what we call the future.

With knowledge of the universe spreading at prodigious rate to cover time and space, with an acquaintance of the history of life on its march through the ages, with rapidly growing knowledge of the steps by which man has come up through gradually rising stages of physical development and culture, it is natural to inquire whether we are not now in position to make assumptions regarding the future of man and of the social organization which he forms. Can we not make such assumptions with expectation that the

attempt to look ahead will help to guide us in judgment on some of our most complicated world problems?

The term evolution of society concerns in reality both what touches the individual and the group. In recent years discussion of advance, so far as it relates to humankind, has shifted largely from consideration of the individual to investigation of evolution in the group and its products collectively.

Organic, or so-called physical continuity, is represented through the succession of individuals. Continuity in the body of knowledge and accumulated experience is represented in society. Man has advanced rapidly in building his own environment. In a sense he has created for himself a new world through accretion of contributions brought by the succession of individuals and of generations, the whole structure being held together by continuing community of interest.

In the purely social sense we are concerned with evolution or advance of methods of organization and with broad subjects, as physics, chemistry, architecture, medicine. Individuals born into this world inherit directly that which is passed on to them in their physical being and in the physical basis of their mental capacity. In the social sense they receive the accumulated benefits of knowledge obtained, organized and protected by preceding generations.

The elements upon which evolution of society depends may be discussed on the basis of many kinds of classification. We recognize advance of this group as dependent upon the common body of knowledge and experience and also upon the capacity of individuals to use these assets. Setting aside for the moment the position of the individual, we may say that advance of the group, or growth of the social heritage, is dependent upon:

(1) The securing of new knowledge by discovery, invention and research.

(2) Unification of knowledge or understanding of the interrelation of its parts; the result being an arrangement in which every item should be seen in its proper perspective or relation to every other item.

(3) Development of adequate means for establishing continuity in knowledge in what we call education of a given generation or in transmission from generation to generation. Failure to have knowledge consolidated in the community by making it common property, or failure to carry the lessons of one period to the next would mean breaking down of civilization, destruction of the advantages of the social organism, or in a large measure destruction of the new world created by man or society. It is important to recognize that education does not mean merely the handing on of information. It concerns true understanding or appreciation of the materials transmitted.

(4) Advance, development or the evolution of society is dependent upon physical and mental effectiveness of the individuals of which it is composed and upon the time available for their work.

(5) Advance of society is dependent upon continuing betterment of its economic and political organization. No matter how far we proceed in other respects, if the machinery of economic life or the methods of political organization fail to give coincidently adequate expression of individual freedom with the fruits of social cooperation, advance or evolution will be retarded.

(6) The furtherance of social development depends in a very fundamental way upon the possibility not merely of making the individual effective physically and mentally and socially, but upon the opportunity also to strengthen the type or enlarge the actual basic capacity of individuals.

The critical question toward which this paper is directed concerns the function of medicine, interpreted in the widest sense, in promoting movement or advance or betterment of the social organization which man has created. The individual in relation to the course of his life reminds one of the rider of a bicycle. He seems safe only if moving and satisfied only when advancing. Life itself is often defined as a form of motion. So society also demands the joy of change. If Wells's "Outline of History" did not convince the public on this point, the "close-up of history" in Mark Sullivan's study of "Our Own Times" will not leave possibility of doubt.

The world is hungry and thirsty for variety and also for verifiable evidences of progress. It is important to satisfy this demand without periodic resort to revolutionary methods like those of war as means of insistence upon particular modes of thought or action or as an outlet for feelings or as an exalted form of sport. Society has seemed almost regularly to turn from its treadmill round of daily duties into the fierce pleasures of making the world safe for this or that kind of economic, political or religious system. It is essential that we learn the joy of growing or evolving through appreciation and construction, instead of through mere accumulation or by the relatively easy method of destroying something.

It is my purpose to inquire whether medicine, instead of being purely palliative, curative and protective, does not make one of its most important contributions in facilitating and supporting the growth process so clearly essential to society.

As has been indicated, the advance of society is dependent upon two quite different types of evolu-

tion: one, the basic element comprised in physical and mental development of the individual; the other, the strictly social element compassed in the accumulation, organization, effective utilization and constructive development of community knowledge. Both features are essential.

One element peculiar to this problem, and to which special attention must be given, relates to the fact that human intelligence recognizes its own place in the world and insists upon expression of individuality in its possessor. The famous words, "I think, therefore I am," might well have been written, "I think, therefore I am independent." We must, of course, not forget that man sees also the importance of society to him. The individual will always assert his right to attention. In any scheme of social organization he is not only the basic element, but he demands the right to live and to grow as far as his intelligence and desires permit. Society has added the condition that this be granted so far as it is compatible with similar privilege for others.

I have already mentioned six items from the long list of elements upon which the evolution of society depends, if it is to proceed on a basis which will guarantee continuing improvement. These points were made without reference to definition of means by which the needs can be met. For our present purposes we wish to know the relation of the contribution from medicine toward meeting requirements of these points.

The *first* need concerned securing new knowledge by discovery and research through which society would better its situation. These advances must be in all possible fields, and medicine could expect at most to have only a modest part. The contribution actually made by medicine is significant, both as to actual addition of new materials and through the indirect effect upon advance of research in many other subjects.

Out of present-day organization of civilization comes the fact that the applying sciences, as in industry and medicine, have become themselves outstanding research instruments, adding much to fundamental principles of knowledge upon which they have been dependent. Such an institution as the Rockefeller Institute for Medical Research, carrying investigation into the foundations of biological and physical sciences, makes large addition to our basic knowledge.

Indirectly medicine and medical research stimulate enormous production of new information in closely related subjects, ranging from physics, chemistry and biology to economics and political administration.

Toward the *second* requirement, namely, the unification of knowledge, it is again true that the application of fundamental knowledge for specific purposes, as in medicine, leads always to the bringing together of data from many sources. The influence of organization of knowledge for the purposes of medicine makes necessary a redefinition of relationships among many other subjects which would not develop easily in other ways.

Upon the *third* point, or the need for establishing continuity of knowledge in education, it is certain that medicine, recognizing the need for knowledge of this subject by the whole people, will exert a great power to extend education so as to carry its meaning not alone through teaching of the young, but by continuing the interest and education of mature persons as well.

In development of the science of war a stage has been reached where operations on a national scale necessarily extend beyond the limits of purely military organization, and involve the interests of the whole people. Similarly in medicine, the larger program of the future can be carried out only by extending the meaning and function of medical science into the understanding and life of every individual, so that the operation becomes in large part that of society.

Many nations and civilizations that have failed might have remained had their general educational system been perfected. The time is not distant when we shall have the people as a whole informed regarding basic facts and sources of knowledge covering human health and its advantages.

Concerning the *fourth* requirement, namely, necessary betterment of physical and mental effectiveness of all individuals, this we may consider the special function of medicine above that of any other organized agency or institution in society.

The contribution of medicine toward this end results in enormous increase in effectiveness of the individual, and therefore an enlargement of the total work, both routine and constructive, accomplished by society. This means also saving of lives, increasing the number of hours' work in a given year regardless of age. It means advance of mental as well as physical effectiveness for all tasks upon which individuals are engaged. The net result is to make production greater, to increase the range or scope of living of the individual, to widen his knowledge and better his judgment. It gives a larger measure of what some have recently called "leisure." I would describe it as "opportunity to live," in the sense of opening the way for appreciation of life as we live it, and for growth within the individual life period. It is not merely with advance that individuals and society are concerned. It is the desire to obtain some advantage or joy of living from advance while it is in progress.

Lengthening life of the individual means not merely more years in which to work; it means greatly in-

creased use of cumulative individual experience. The number of persons over fifty years of age to-day, but still working hard with sound bodies, clear minds and enthusiasm of youth is greatly beyond that of earlier decades. Organized knowledge possessed by the individual is still more effectively handled than organized knowledge controlled by society. Up to the present time the mental mechanism of the individual has been more efficient and works more smoothly than the interplay of parts in society.

As medicine goes forward in development of its constructive policies it will not merely hold back what we consider preventable disease or ill health; it will go far in elimination of much that has been recognized as a part of the normal heritage of ills fastened on humanity. The individual of the future will have relatively large freedom from ills that limit other organisms. The new world which man creates will not only have the advantages of accumulated knowledge—it will have a clearer field for living and for use of knowledge than has yet been known to living beings.

I have no illusions regarding seriousness of dangers brought about by possibility of degeneration of the race through breeding from weakening stock, owing its existence to protection of society. Nor have I doubt concerning the dangers arising from crowding the world with people who have left to them little opportunity for individuality and less for development.

It is clear that certain aspects of natural selection tend to counteract some of the dangers just mentioned and that without a process of rigorous selection we must plan to meet these risks in some other way. I believe that we shall be wise enough to overcome these obstacles and to rid ourselves of the risk of breeding from weak stock. We shall some time come to recognize that deliberately bringing into life people already doomed to a heritage of suffering and of social disadvantage may be a crime comparable to that of taking life away from those already favorably situated.

The *fifth* point, relating to the necessity for contribution toward betterment of economic and political organization, is met by medicine in a larger measure than might be expected. Improved physical and mental health make for higher thought and life, thus laying foundations for bettered organization. Like the delicate adjustment of modern machinery, possibilities of social organization are limited by delicate but real distinctions, such as can be appreciated only through clear minds made possible by sound bodies. Many kinds of finely adjusted social mechanism, which might be operated by a people relatively free from physical and mental disturbances, would be impossible under conditions where widespread ill health and disease gave a different mental cast to society.

It remains also to be seen how great the influence of medicine may be in direct effect upon economic and political organization as guided by desire for health and fear of disease.

The *sixth* point, relating to dependence of social evolution upon the continuing physical and mental development of the individual, in the sense of his fundamental capacity and power, represents perhaps the most critical item of those upon which the future of society depends. It concerns the possibility of extending such a type of physical evolution as has characterized the organic world through the vast ages over which our known history of biological progress reaches, and has continued itself clearly in the history of mankind.

The problem of human betterment and advance through increasing the physical capacity and power of the individual represents one of the most important opportunities for biological science. The more narrowly limited aspects of this study have been included in the field of eugenics, which rests upon genetics in cooperation with every branch of science which concerns heredity and environment of the individual.

To open the way for a rate of advance in physical being for mankind at least comparable to that which has characterized man in his past history, eugenics must have a program which will include: (1) a full knowledge of the laws which govern heredity, (2) an understanding of any extra-individual or environmental forces which may affect the individual, (3) an understanding of the history or evolution or development of man and of other related organisms, with an interpretation of the processes which are illustrated by this course of development, and (4) an understanding of the ways by which society through its organized effort can properly influence or direct physical development of the individual in such a manner as to strengthen the type.

The study of these problems of biology applied to man represents one of the most interesting groups of investigations needed in the immediate future. It is to be assumed that through knowledge of individual and race history in other types of life we will come to understand in most respects the biological factors involved in human development. The fundamental principles of genetics will be found inextricably interwoven with basic laws of physics and chemistry. There will be many questions concerning the extent to which certain of the outstanding features in genetics of other organisms actually apply to the case of man. We shall need demonstrations sufficiently clear to bring conviction.

In the problem of development of the individual in the human group we shall meet complications not

known in study of other organisms. They will arise on the one hand out of the extreme development of our individuality, and on the other hand out of imperfectly understood influences of the community upon the individual.

There is every reason to believe that with the tremendous advance that natural science has made in understanding of the biological world, and that social science has made in interpretation of our outstanding peculiarities, we shall ultimately come to a place at which man will be able to take advantage for himself both of the laws of nature which have brought his development to the present stage and of the vast social heritage of knowledge which may be used for his future guidance. It seems impossible to believe that the introduction of intelligence into the scheme of evolution could, as some have believed, result in disasters such as are assumed to be inherent in civilization.

I believe Bryant had something of a vision when he wrote, "He who has tamed the elements, shall not live the slave of his own passions." Intelligence should make possible for a man a degree of progress at least comparable to that by which he has come to the present stage.

As, then, we review the elements which seem required if society is to proceed in its advance, it is clear that medicine in the broader sense has important relation to all the factors discussed. In certain fields its contribution is the largest made by any combination of art and science. It is the greatest factor concerned with increasing physical and mental efficiency, saving life, lengthening life and thus increasing productiveness and lifting the quality of judgment. Its direct influence in betterment of the physical stock of mankind and preparing the way for evolution is so clearly essential that without it evolution could hardly proceed.

It is not to be assumed that medicine unaided can prepare the way for continuing growth or evolution of the human group. In such a work the activity described as medicine will represent concentrated effort of many correlated fields. Chemistry, physics, biology and the anthropological and social sciences would all participate. It may be that the medicine of to-morrow will be so different from what is practiced to-day that in the language of the present it would be more readily described under designation of the sciences from which it will be composed.

The principles which will make possible the physical basis of future mental evolution of the individual and the foundations of a broader and stronger social organization will grow from application of fundamental laws or modes of procedure which biology and other sciences still find elusive and almost incomprehensible. Even the farthest advances of present research fall far short of what we need to know concerning how man may best proceed along the path of evolution. And yet it is part of my thesis that without the work of medicine in preparation of the way by bettered physical condition, improved health, increased mental efficiency, lengthening of life and pushing back of the invading hosts of disease; without embedding of scientific and medical knowledge in the minds of the people by education; without development of a more favorable physical, biological and intellectual environment in response to requirements of the new medicine;—without these contributions of medicine, it could be only through almost miraculous modification of laws guiding nature and man in the past that an intelligent society could expect to advance to greater heights. Medicine will sweep away many of the handicaps that have limited human life in the past and will also help to make more clear the laws that govern our growth.

Medicine of the future will continue refinement of its art and will develop skill comparable to that in the highest coordinated work of human hands, as in their translation of music through playing upon the instrument. Linked with the whole range of organized investigational effort, it will help to extend research to realms as remote, compared with our vision to-day, as the electron was to the scientific world of our great-grandfathers. It will bring to every worker in the field, at the same time, a better appreciation of the importance of the art of medicine and a recognition of the need for understanding as to the real limits of our knowledge.

In my boyhood I read with surpassing interest the tales of knights who devoted themselves to the not altogether unattractive business of slaying dragons and other undesirable monsters. When I came to the age at which I might enter upon adventure, the dragons had vanished. But I spent some interesting years in helping to bring life into the bones of many ancient monsters buried beneath rocks and mountains that had themselves almost succumbed to ravages of time. The actual dangers of our expeditions from rattlesnakes and bears and ticks carrying Rocky Mountain fever, and coyotes with hydrophobia were probably equal to those of dragon hunting in olden times, and I enjoyed the sport. The result of our work was, I trust, a small but real contribution to knowledge of movement of life through the ages—and of the meaning of the continuing process of creation.

And now that I have seen these visions—one, through distorted legends handed down from remote centuries, the other, a verifiable story of creation and its meaning—my interest shifts to that growing edge, where life passing through the ages determines in a measure the trend of its own future. My concern is

now with utilization of what we have to-day, trusting that, in the light of what we know from the past, it may be turned to advantage for future guidance.

I see in medicine a field of human endeavor, not only essential for well-being and enjoyment of the moment, but carrying unavoidable responsibility for that advance of mankind upon which its happiness will depend. Constructive effort in this subject will serve not only to turn the tide against the deadening influence of disease and ill health, but to exert also in some measure a creative influence. We see the forward movement of life in the remotest beginning of beginnings as we know them. To living, hoping human beings this movement can not seem naturally to terminate in any conceivable end of endings.

JOHN C. MERRIAM

CARNEGIE INSTITUTION OF WASHINGTON

RESEARCH AND THE UNIVERSITIES[1]

IT gives me pleasure to welcome you to-day as guests of the University of Pennsylvania. As the head, for the time being, of a university, I am deeply interested in the problems of scientific research in which you have gained distinction, and in which you are still engaged. A conference called by a half dozen university presidents was held at the university last spring for the purpose of discussing research as carried on in the universities, its relation to the work of research institutes and to the great industrial corporations. There were present at the conference representatives of the universities, the research institutes, and the industrial corporations. Several important facts were emphasized by those who participated. From the point of view of the universities perhaps the most important fact is that they are almost invariably the source of training of researchers in every field of science, and the research foundations and industrial corporations look to the universities for the trained men and women to carry on the work. A second point of interest is that if research workers are to be withdrawn from universities to do the work of research institutions and of industrial corporations, it is important that universities be protected against such withdrawals of those who are in many cases their ablest teachers and investigators. The questions of immediate importance to all who are interested in scientific research are, first, how shall we train and encourage young men and young women to engage in scientific research, and how shall we afford those who are particularly qualified the opportunity to proceed without interruption along lines of study often begun with the doctor's dissertation. Is it possible for universities to set apart more or less completely from the work of teaching a number of men and women who if given the chance would probably develop into important workers in the field of science, or of any other subject included in the courses of study of our institutions of higher learning? It too often happens, as has been pointed out, that the brilliant young student is at once taken as a member of the teaching staff of his institution and loaded with teaching and administrative work to the detriment of his work in scientific investigation. I believe that practically all members of a university staff should do some teaching, not only for the development of their own minds, but also for the establishing of necessary contacts with possible future workers in their respective fields, and I believe also that many a possible research worker has his interest dulled by the routine of too much teaching. An effort that we are making at this university to solve this problem, in part at least, is based upon the idea, that a roster may be so arranged that several days in each week may be left free for the teacher to spend in his laboratory. Of course the real researcher will work in spite of unfavorable conditions, some working all night. It is not the fact that teachers do not have time to do research, but rather that their time is so broken up by teaching that it is ordinarily exceedingly difficult to obtain sufficient uninterrupted days, in which to engage in serious and continuous pieces of work. It is necessary also for universities to provide sufficient laboratory space, and a freedom from interruption, to encourage the undertaking of research work, particularly by the younger members of the faculty. In one of our scientific departments, the experiment is being made of placing all the teaching hours of the members of the faculty on certain days of the week, leaving several other days entirely free from teaching or administrative duties. This is already beginning to show results, and more results are expected as we are able to develop the system more extensively. I believe that this plan could be adopted by almost any institution, which possesses the necessary laboratory space and the necessary potential workers in the field of science. The universities are the places to which the world looks for the fundamental training of research workers, and it is important that every facility be afforded both the universities and the workers to develop human knowledge.

It is essential that research be planned and directed particularly in universities, and here we find it necessary to differentiate between the research work of the university and the research work of special in-

[1] Address of welcome to the National Academy of Sciences by the president of the University of Pennsylvania, November 8, 1926.

stitutions or of industrial laboratories. Perhaps the most important university function of an institution of higher education is that of increasing knowledge, and it must be recognized that productive scholarship is the usual test of the intellectual life of an institution.

There are two aspects of research; one of these is the work of research as a means of the solution of certain so-called practical problems, the other is research in general the object of which, while it may incidentally prove to be practical, does not have practicality as its end and aim, but merely the increase of human knowledge. In the universities, perhaps alone, is to be found in its most complete expression the spirit of pursuing knowledge for its own sake. There also is to be found the complete circle of human knowledge. The chemist, the historian, the mathematician, the geologist, the philologist, preserve a breadth of vision and a sense of proportion, owing to the fact that they are linked side by side in the same institution. Moreover the student in one field frequently finds in his own subject problems that require aid from the student in some other field. The universities, therefore, offer the best combinations of knowledge that are to be found in the world. From the university come the research workers of the future. The achievements in applying science may be justly and generously credited with great accomplishments, but all achievements of applied science rest upon the work of men and women who were, for the most part, university trained, and interested in the fundamental laws of nature rather than in any practical application of them. It is a distinct function of a university to advance knowledge all along the line, and to give to the world these additions to knowledge by which alone we can grow.

The National Academy of Sciences, composed as it is of the products of university education, is also the highest scientific body in this country. Its members are living exemplars of what universities have done, and they are also exemplars of what individuals have done who possessed and were possessed by the spirit of research, and who used their university foundations and principles merely as stepping stones to higher things.

JOSIAH H. PENNIMAN

FELLOWSHIP IN THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ONLY fellows of the American Association may serve as elected members of the council or elected members of the section committees and only fellows may be representatives of the affiliated organizations in council and section committees. These are constitutional provisions (Constitution, Articles 4 and 5). Members who are not fellows may be elected to other offices and may be elected or appointed to other committees. In actual practice, however, the *ex-officio* members of the council and of its executive committee (the president of the association, the general secretary, the permanent secretary), as well as the section officers (chairman and secretary, the chairman being also *ex-officio* a vice-president of the association) are always fellows. The control of the affairs of the association is consequently in the hands of fellows. The council is the legislative body for the association as a whole, the executive committee acting for it at times other than during the annual meetings. The section committees are generally the legislative bodies for their respective sections, though action is sometimes taken by a section at one of its sessions. The permanent secretary and the section secretaries are the executive officers.

It is intended that the group of fellows shall include those members of the association who have contributed to the advancement of science by the publication of original scientific research or in other significant manner, such as teaching or directing research in an institution of repute. (By-Laws, Article II, Section 4, and special interpreting clause of December, 1924. See *Summarized Proceedings*, 1925, page 13.) This requirement is considered to have been met by members of affiliated organizations having a research qualification; on the basis of this statement the following categories of membership in affiliated organizations are now understood to imply eligibility to election to fellowship in the association.[1]

Fellows of the American Physical Society.
Fellows of the American Meteorological Society.
Regular members of the Optical Society of America.
Members of the Geological Society of America.
Fellows of the Mineralogical Society of America.
Members of the Association of American Geographers.
Active members of the American Society of Zoologists.
Fellows and honorary fellows of the Entomological Society of America.
Active members of the American Association of Economic Entomologists.
Members of the American Society of Naturalists.
Members of the American Psychological Association.
Members of the American Association of Anatomists.

[1] This list has been carefully prepared, but it may require additions from time to time. If an affiliated organization has research qualifications for its membership, or for a category of its membership, and if it is not properly cared for in this list, its secretary should take up this matter by correspondence with the permanent secretary of the association.

The secretary of each section is expected each year (with the assistance and advice of his section committee and the secretaries of the affiliated organizations of his section) to go through the list of members enrolled in the section, nominating for fellowship all members on the list who are not already fellows and who are eligible to election to fellowship because of the advancement of science by the publication of research or in other significant manner, including those who are eligible because of membership in one or more of the special categories just listed.

The section lists are taken from the regular roll of the association, being maintained up to date by cards sent to the section secretaries from time to time, and each name is accompanied by one, two or three letter symbols indicating the one, two or three sections in which, as the member has intimated, he is specially interested. The order of these symbols, when more than one occur, shows the member's relative interest; for example, ABD denotes greatest interest in mathematics, secondary interest in physics and tertiary interest in astronomy.[2]

After the eligibles on any section list have been nominated each nomination is referred to the section committee for the section indicated by the *first* section symbol on the nominee's record card. Thus, a member whose name is accompanied by the letters ABD is represented by a card in each of three section lists and may be nominated for fellowship by any or all of the three section secretaries concerned. In this case the nomination would be referred to the section committee of Section A. In many cases the section secretaries cooperate in making nominations, generally also securing advice from the secretaries of affiliated organizations or from the council representatives from those organizations.

[2] These letter symbols appear on the addressograph plates used by the Washington office in addressing annual statements to the members. If no section symbol appears this means that the member has intimated no special interest in sections and he is enrolled simply as a member of the association as a whole. Names without any section symbols do not appear in any section list. Each member should note carefully the imprint from his plate, making sure that the plate is kept correct in every detail, including the letter symbols referring to sections. The symbols used are just the letters designating the sections; A for Mathematics, B for Physics, etc. Be sure that the order of their appearance on the plate is correct. The plate also bears a membership formula indicating the year the member joined, the year of his election to fellowship, if he is a fellow, and the year of his becoming a life member or emeritus member if he belongs in one of those groups. The formula 20, F22, L25 means membership since 1920, fellowship since 1922 and life membership since 1925. A member may receive an imprint from his plate at any time from the Washington office.

After reference to the proper section committee, the nominations for fellowship are returned to the Washington office, marked *approved* or *disapproved* (with an explanatory note if the nomination is disapproved), and those that have been approved are then referred to the executive committee, which may vote the elections or recommend them to the council for election. After election by council or executive committee, each new fellow is notified, receiving the certificate of fellowship, and his addressograph plate is altered so as to show him as a fellow.

In uncertain cases, nominations may be referred, before going to the council or executive committee, to a special committee on fellowship, consisting of the general secretary, the permanent secretary and the secretary of the section in whose field the nominee's scientific work lies.

Our present organization for the nomination and approval of new fellows is not as efficient as it might be; all section secretaries and their committees do not operate with the same degree of efficiency, precision and promptness, and it may frequently occur that a member who should be elected to fellowship fails for several years to receive this important election. It is hoped that these difficulties may be overcome through the hearty cooperation of all the officers concerned. But it should be emphasized that the by-laws specifically state that nominations for fellowship may quite legitimately, and in all respects properly, be made by the member himself in any case. If a member is not a fellow and has reason to think he should be elected to fellowship, he should write fully about his case to the permanent secretary, who will see that the nomination is referred to the proper section committee and, if duly approved, brought to the executive committee or the council. Any member may nominate any member (including himself) for fellowship. New members may nominate themselves for fellowship at the time of joining if they judge that they are eligible. Fellowship nomination blanks are obtainable from the permanent secretary's office at any time.

This matter of fellowship is important in the association, especially on account of the fact that the activities of the organization are in the hands of the fellows, through the council. There are now about 5,200 fellows, representing about 36 per cent. of the total enrollment. No special obligations are entailed by fellowship. If a fellow resigns from membership or if his name has to be dropped from the roll on account of more than two years of arrearage in the payment of dues, his status as fellow is of course discontinued, but if he subsequently becomes reinstated or rejoins the association he is then automatically given the rank of fellow without a new election to fellow-

ship. The name of each fellow is specially designated by an asterisk in the quadrennial directory of members, which makes up the larger part of each volume of Summarized Proceedings.

BURTON E. LIVINGSTON,
Permanent Secretary

WILLIAM JOSEPH HUSSEY

WILLIAM JOSEPH HUSSEY, fifth director of the astronomical observatory of the University of Michigan and professor of astronomy, died in London on the twenty-eighth day of October, 1926. Three weeks before, he had set out from Ann Arbor for Bloemfontein, South Africa, on a project that marked the culmination of years of planning and effort—a project involving the erection of an observatory and the installation of the twenty-seven-inch Lamont refractor primarily for the prosecution of a double star survey of the southern skies. While waiting to continue his journey from London death, caused by heart failure, came instantly as he and Mrs. Hussey conversed with friends at the dinner table.

Born in Ohio, August 10, 1862, on a farm where funds were limited, an education was not gained without a struggle. Teaching and other work needed to eke out available resources interfered with progress in study to such an extent that it was not until 1889 that Professor Hussey received his bachelor's degree. He graduated in civil engineering from the University of Michigan, with a brilliant record. For a time in 1889 he was an assistant in the Nautical Almanac Office at Washington, D. C.

Then began a period of seven years devoted principally to teaching. Instructor for three years at Michigan in mathematics and astronomy and acting director of the Detroit Observatory during the last one of these years, he was called to Leland Stanford Junior University as assistant professor of astronomy in 1892 and rose in three years' time to a full professorship in that subject. During this period he visited the Lick Observatory frequently as a volunteer observer. It was during this time that his remarkable photographs and studies of the physical characteristics of Comet Rordame were made. His appointment as successor to Barnard at Lick Observatory came in 1895.

The years as astronomer at Lick Observatory, from 1896 to 1905, formed for Professor Hussey a period of most intense activity in research. Space is lacking to consider the details of his researches there. His photographs, orbits and micrometer observations of comets, his drawings of the planets, his micrometrical observation of satellites and asteroids, but most of all his epoch-making discoveries, measures and other investigations of double stars brought him international distinction and the widest recognition.

Professor Hussey's most notable achievements at Lick Observatory were his observations of the double stars discovered at Pulkowa and his discovery and observation of 1,338 new double stars. The report of the former studies fills Volume V of the Lick Observatory Publications, a model of its kind. The discoveries of double stars resulted from a survey begun independently in 1899 by Dr. R. G. Aitken and Professor Hussey but pursued jointly by them almost from the first and completed by Dr. Aitken working alone after 1905. This great work with related investigations won for both collaborators the Lalande Gold Medal of the French Academy in 1906. Subsequently, at La Plata, Professor Hussey, observing in the southern skies, increased the total of his double star discoveries to 1,650.

Dr. Hussey returned to Michigan as professor of astronomy and director of the observatory in October, 1905. Though always assuming his full share of teaching, in which he was notably successful, and finding time for countless other tasks, he nevertheless kept before him always the larger problems connected with the growth and extension of the observatory. The initial program of construction for Ann Arbor, beginning with the buildings, instrument shop and smaller instruments, culminated in the 37½-inch reflector. When this instrument was completed with its spectrographic equipment and auxiliaries in 1911, the original plans for reorganization and construction at Ann Arbor were essentially realized, and a period of research began.

At this juncture there came an opportunity for similar offices at a great southern institution. The observatory at La Plata, in Argentina, had expended considerable sums of money but then lay dormant with a group of sightly buildings and a complement of equipment needing only the attention of experts to make it productive. A cooperative arrangement was formulated under which Professor Hussey was to add the duties of the professorship and directorship in astronomy and geodesy at the National University of Argentina in La Plata to those at the University of Michigan, dividing his time about equally between the two institutions. When this was quickly approved by the regents of the University of Michigan, the incident was a source of much gratification to many interested in the betterment of Pan-American relations and to those interested in scientific progress.

Arrived in Argentina, July 19, 1911, it was found that the attitude of the University of La Plata was cordial and entirely favorable. However, unexpected difficulties in securing full authority at the observatory were disheartening for a time. But soon with

characteristic vigor the work of reorganization was under way. When Professor Hussey sailed for the north on January 8, 1912, new contacts were firmly established, far-reaching plans were well matured, and a list of nearly one hundred double stars discovered with the La Plata refractor carried deep significance in connection with plans for a double star survey of the southern sky.

The cooperative arrangement with La Plata University continued for six years. Professor Hussey's return to Argentina in the summer of 1912 for a stay of eighteen months began a period of rapid progress at La Plata. Delavan, Dawson and Crump joined the staff, the former members of which were stirred with new vigor. H. J. Colliau, of the Detroit Observatory, superintended the erection and equipment of an instrument shop and put the Gautier Meridian Circle, the 433-millimeter refractor, the astrographic telescope and the comet seeker into full working order. Regular observations with refractor, meridian circle and other instruments, begun at this time on a large scale, continue to-day through the able efforts of Dawson, Manganiello, Martinez and others. The eighth of a series of La Plata volumes, a series begun by Professor Hussey in 1914 and containing the results of work much of which was directly organized and inspired by him, is now on our shelves and the end is surely not yet.

It was in 1908 that Mr. R. P. Lamont, of Chicago, a friend since college days, was ready to finance the plan that Professor Hussey and he had kept in mind for a number of years. Designs and detailed drawings for a telescope mounting began at Ann Arbor in 1910. The contract for a 24-inch lens was placed with the Alvan Clark & Sons Corporation in 1911. Glass-makers in France famous for their successful production of great telescope discs failed repeatedly in their attempts to produce 24-inch blanks, and when a German firm succeeded in making them war conditions prevented delivery. At last in 1922, it was learned that discs of glass exceeding twenty-seven inches in diameter were in the making at Jena subject to order. No time was lost in applying for them and as little extra work on the mounting was entailed through the increase in contemplated diameter there was at last in the face of heartbreaking delays a real consolation in the prospect of an instrument of signally increased power.

McDowell's work in figuring the 27-inch lens began early in 1923. In October he reported completion approaching. A month later came the wire announcing his tragic death. Professor Hussey learned of this in Africa, where he was seeking a site for the new telescope. A year later still the lens in Hageman's skilful hands tested without a flaw. On January 27, 1925, the 27-inch lens arrived in Ann Arbor to prove itself on the stars in its finished mounting. Yet more delay followed through difficulties encountered in securing a satisfactory contract for the 56-foot dome needed for the successful operation of the telescope. This was arranged just before the expedition sailed.

Three weeks later the plans so fully perfected by Professor Hussey fell into other hands. Almost as soon the University of Michigan and Mr. Lamont had united in the determination that they should be carried out. Dr. R. A. Rossiter, waiting in London, was authorized to proceed to Bloemfontein to erect the building and receive the telescope already far on its journey to Africa. With other features of the program provided for, it is expected that scientific results may be secured that will serve fittingly as one of the many memorials that Professor Hussey has left behind him.

Concurrently with the progress of the southern expedition, projects for increased facilities in astronomy at Ann Arbor were under way. Professor Hussey had practically realized present plans for the equipment of the astronomical laboratories on the upper floor of the new building for the college of literature, science and the arts. For some years Professor Hussey had been formulating plans for a new research observatory for the University of Michigan with confident expectation that they would be realized. The present site for whose protection Professor Hussey worked so earnestly becoming untenable by encroachment of railroad, power house and other close buildings, he joined in the selection of a suitable observatory site well removed from disturbing conditions. He planned for this site greatly improved instrumental equipment and counted also on the construction of a research office building and laboratory on the campus at Ann Arbor.

Honors began coming to Professor Hussey early in his career. He was elected president of the Astronomical Society of the Pacific for the term of 1896–1897. In 1903, he was made a foreign associate of the Royal Astronomical Society of London. The following year he was made an honorary member of the Mexican Astronomical Society. In 1906 he received the Lalande Prize of the French Academy for discoveries and investigations of double stars. He was secretaary of the American Astronomical Society from 1908 to 1912 and during that time compiled the initial volume of the publications of that society and edited part of the second volume. He also served two terms on the council of this society. He received the honorary degree of Sc.D. from Brown University in 1912 and served as president of the Research Club of the University of Michigan for the term 1919–1920.

His publications began to appear early. "Loga-

rithms and other Mathematical Tables" and "Mathematical Theories of Planetary Motions" (a translation by Harrington and Hussey) together with several technical papers appeared during his residence at Michigan and Stanford Universities. While at Lick Observatory his "Micrometrical Observations of Double Stars discovered at Pulkowa" appeared as Volume V of the Lick Observatory Publications, and in addition he contributed about 130 technical articles to various astronomical periodicals during that time. Subsequently, the total of his technical articles had increased to more than one hundred and seventy.

Professor Hussey's only respite from hard work was found in travel and his journeys were always of an expeditionary character. In 1903 his search for observatory sites in behalf of the Carnegie Institution took him to Arizona, Southern California and Australia. At this time he reported favorably on the present site of Mount Wilson Observatory. In 1905 he headed the very successful Lick Observatory Expedition to Egypt. In 1911 his four journeys to La Plata began. In 1912 he conducted an eclipse expedition to Brazil, but clouds prevented observation. In 1923 he extended his search for observatory sites to Africa. In 1925 at Geneva, New York, he sat in the basket of a balloon ready to ascend under perilous conditions to observe the eclipsed sun from an elevation above the clouds. Expert balloonists forbade the flight. He was embarking on the major expedition of his career when death came.

The University of Michigan has lost a prominent scientist, educator and administrator. Astronomy has lost one of its distinguished contributors, organizers and builders. Those of us who were close to Professor Hussey mourn the loss of a generous and loyal friend.

R. H. CURTISS

ANN ARBOR, MICHIGAN

SCIENTIFIC EVENTS

AWARD OF PRIZES BY THE FRENCH ACADEMY OF SCIENCES

THE following prizes have been awarded by the French Academy of Sciences for the year 1926:

The Poncelet Prize (2,000 fr.), Paul Montel, professor of mathematics at the University of Paris.

The Francoeur Prize (1,000 fr.), Gaston Julia, professor of mathematics at the University of Paris.

The Montyon Prize (1,500 fr.), Professor Kyrille Popoff, of the University of Sofia.

The Henri de Parville Prize (1,500 fr.), Colonel Antoine Alayrac, chief engineer of the Bureau of Aeronautics.

The Henry Bazin Prize (5,000 fr.), Leo Escande and Marcel Ricaud, lecturers in electromechanics at the University of Toulouse.

The Montyon Prize for Pathological Industries (2,500 fr.), Ernest Portier, inspector of education for the Seine district, and (1,500 fr.) Louis Chelle, professor of chemistry at the University of Bordeaux.

The Jecker Prize (6,000 fr.), André Wahl, professor of industrial chemistry at the University of Paris, and (4,000 fr.) Gustave Vavon, professor of organic chemistry at the University of Nancy.

The La Caze Prize (10,000 fr.), André Job, professor of chemistry at the University of Paris.

The Cahours Foundation Prize, Raymond Delaby, of the School of Pharmacy, and Michel Samsoen, engineer.

The Hirn Foundation Prize (2,500 fr.), M. Thoret, of the air force.

The Becquerel Foundation Prize (3,000 fr.), Georges Bruhat, professor of physics at the University of Lille.

The Houzeau Prize (700 fr.), Louis Hackspill, professor of mineralogical chemistry at the University of Strasbourg.

The Berthelot Medal, Ernest Portier, winner of the Montyon Prize and André Job, winner of the La Caze Prize.

The Serres Prize (7,500 fr.), Charles Pérez, professor of zoology at the University of Paris.

The Vaillant Prize (4,000 fr.), Mme. Lucie Randoin, director of the laboratory of research in nutrition at the Institute of Agronomical Research.

The Jean Reynaud Prize (10,000 fr.), to the late Alfred Giard, member of the Academy of Sciences.

The Saintour Prize (3,000 fr.), Pierre Fauvel, professor of zoology at the University of Angers.

The Longchampt Prize (4,000 fr.), Charles Dhéré, professor of physiology at the University of Freiburg.

The Wilde Prize (2,000 fr.), Professor Armand Renier, of the University of Liège, and (2,000 fr.) M. Bruneau, explorer.

The Caméré Prize (4,000 fr.), Raoul Féret, director of the laboratory for research in the construction of bridges and roads.

The Gaston Roux Prize (1,000 fr.), M. Chevey, assistant at the museum of Natural History.

The Thorlet Prize (1,600 fr.), Adolphe Richard, former assistant at the School of Mines.

The Albert 1st of Monaco Prize (100,000 fr.), Jean Charcot, the explorer.

The Tremont Foundation Prize (1,000 fr.), Edmond Marcotte, advisory engineer at the mines of Laluque.

PRESENTATION OF THE ROYAL SOCIETY'S MEDALS TO SIR FREDERICK G. HOPKINS AND DR. D. H. SCOTT

IN presenting the Copley medal to Sir Frederick Gowland Hopkins, and the Darwin medal to Dukinfield Henry Scott at the anniversary meeting of the Royal Society the following citations were made:

For twenty years Sir Frederick Hopkins has been a foremost leader in biochemistry, a branch of science that

has grown rapidly in importance and influence during this period. The guide and director of a great research laboratory in Cambridge, he is everywhere recognized as one of the great pioneers of his science. In his active life he has made a series of fundamental discoveries, each of which has led to the opening up of new fields of work. The isolation and identification of tryptophane twenty-five years ago, at a time when but few of the amino-acids that enter into the composition of proteins were recognized, marked an epoch in the pure chemistry of these substances. The importance of this discovery was enhanced by Hopkins's later work on this substance, which led to a revolution in the physiology of proteins in nutrition, the end of which is not yet in sight. Some of the most fruitful work in recent physiology has been upon the nature of muscular contraction. The work of A. V. Hill and Meyerhof, of Embden, and many others, turns upon the fundamental earlier discoveries by which Hopkins, in collaboration with W. M. Fletcher, defined the conditions governing the appearance of lactic acid in muscle during activity, and its disappearance during recovery. One of the most important discoveries of this century is summed up in the word "vitamins." Fifteen years ago, Hopkins had carried out experiments which not only showed that appropriate mixtures of proteins, carbohydrates, fats and salts, might, for lack of traces of unknown substances, be inadequate for the nutrition of animals, but also at the same time established the general lines of the methods used ever since in the investigation of these substances, by important groups of biochemists in all parts of the world. The discovery of the dipeptide glutathione, coming at a time when the nature of the processes underlying biochemical oxidations was the subject of significant work in many laboratories, has again brought Hopkins into the van as a leader in yet another part of the field of biochemistry and given the signal for intense renewed activity there. Hopkins's work throughout has shown a genius for discovery. It has inspired a very large part of the best work in biochemistry in this century.

At a moment when there seemed some danger that the brilliant advances in paleophytology made by Professor Williamson might slacken owing to advancing years, Dr. Scott entered upon a fruitful cooperation with the veteran. Several joint memoirs were the result of this happy coalition; but later Scott established a quite independent position of his own. Among the numerous memoirs published by him during the last forty years, none stands out more prominently as a model of presentation of complex structure than that on Cheirostrobus, a new type from the Calciferous sandstone. Not only was its elaborate structure fully described, but also the comparative treatment showed a master hand. This quality came out with even greater effect in the study of the new class of the Pteridosperms, or primitive seed-plants with fern-like habit. The extensive knowledge of these early land-plants which we now possess has been mainly based upon the work of Scott, Oliver and Kidston. Such work, of which these examples do nothing more than suggest the nature and the scope, has been gathered up by Scott into his "Studies in Fossil Botany," now in its third edition. It deals primarily with early vascular plants, placing them in natural relations to their living correlatives, and giving a picture of early land-vegetation that has never been surpassed in clarity of presentment, combined with accuracy of detail and of reference. It supplies not only a great mass of fact that is positive and new; but it also subjects those facts to a detailed criticism and a philosophical treatment such as Darwin himself would have been among the first to appreciate.

APPOINTMENT OF A. V. HILL TO THE BAKER LECTURESHIP AT CORNELL UNIVERSITY

IT is announced by Professor L. M. Dennis, head of the department of chemistry at Cornell University, that Dr. Archibald Vivian Hill, F.R.S., Foulerton research professor of physiology in the University of London and Nobel prizeman in medicine, will fill the George Fisher Baker non-resident lectureship in chemistry in Cornell University throughout the second semester of this academic year, from February to June.

The lectureship was founded and endowed last year by George F. Baker, of New York. Previous incumbents of the chair have been Professor Ernest Cohen, of the University of Utrecht, and Professor Fritz Paneth, of the University of Berlin, who is lecturing there this term.

At the age of forty, Professor Hill is one of the youngest of the fellows of the Royal Society, to which he was elected in 1918. His wife is a sister of John Maynard Keynes, author of "The Economic Consequence of the Peace." He was educated at Trinity College, Cambridge, and after graduating with honors and several prizes he was a fellow of that college for several years and then a fellow of King's College, Cambridge, and university lecturer in physical chemistry. He held a professorship in the University of Manchester for four years until 1923, when he accepted the Jodrell professorship of physiology in University College, London. The Royal Society established the Foulerton research professorship in physiology in London in 1924 and Professor Hill is the first incumbent. The Nobel prize in medicine was awarded to him in 1922.

Professor Hill has made important studies of the chemistry and mechanism of muscular contraction, using athletes as experimental subjects, and he plans to develop these studies still further while he is at Cornell. The university athletic association has offered to give him all possible aid. He is eminent not only in physiology but also in mathematics, physics and physical chemistry. He has brought these

special endowments to bear upon the solution of physiological problems and his investigations in this field have been of great importance.

A Royal medal of the Royal Society was recently awarded to Professor Hill and was presented at the anniversary meeting of the society on November 30 with the following citation:

Professor A. V. Hill has made important contributions to knowledge of muscle and nerve. As to the former, his inquiries, begun some sixteen years since, were taken up at a time when, owing to the emergence of new facts, views of general acceptance stood in essential need of re-examination. In the past seven years Hill has accomplished this with a success beyond expectation. He has related to the mechanical the thermal aspects of muscular activity with a precision hitherto unattained and obtained data as valuable for the chemical as they are fundamental for the physical study of the problem. The technique developed by him enabled for the first time the discrimination, in the heat production of muscle, of successive quantities and rates characterizing successive stages of that activity, in spite of the closely consecutive and in part evanescent character of those phases. "Initial heat," uninfluenced by oxygen, the immediate accompaniment of the mechanical changes in the muscle, was thus distinguished from a "delayed heat" associated with functional recovery of the muscle; and in this latter there were recognized two portions which evaluate the relative shares of aerobic and anaerobic disappearance of lactic acid in the processes of restoration of the muscle. In association with this recovery process the molecular ratio between removed and oxidized lactic acid has thus been estimated. Besides furnishing this essential analysis of the functional reactions of isolated muscle, Hill has prosecuted notable inquiries into the factors conditioning the performance and maintenance of muscular effort in the human body, measured its chemical cost and traced to their causes certain of the limits set to the speed and endurance of the athlete. Further, he has succeeded not only in detecting but also in measuring heat-production accompanying the conductive activity of nerve. The scale of energy-change involved in this has required the devising of a refined technique; here again he with his pupils has obtained and measured the heat not only in block but also in its separate phases of production. Whenever the intimate mechanism of the activity of muscle and nerve may finally be elucidated, it is certain that the contributions of Professor Hill will remain fundamental for the explanation of the mechanism of them both.

APPROPRIATION BILL OF THE DEPARTMENT OF AGRICULTURE

THE appropriation bill for the U. S. Department of Agriculture, carrying $128,362,385 for the fiscal year ending June 30, 1928, was reported to the House on December 13 from the appropriations committee. There is also available for the year $11,351,250 out of permanent appropriations under previous legislation.

The budget of the department for the next fiscal year would therefore total $139,713,635. The bill is $4,774,185 under estimates approved by the budget bureau.

The following is a summary of the bill:

For the secretary's office, including $657,000 for salaries, $1,071,366 rentals and other items, with salaries and expenses of the office of information, including publicity personnel, $1,115,000; salaries and expenses of the library, $84,180; office of experiment stations for administrative and general expenses, $3,719,386, and extension service, including cooperative work, reclamation demonstration, agricultural exhibits at fairs and administrative expenses, $2,877,480. This brings the grand total for the office of the secretary to $8,867,412.

Weather Bureau, $2,641,000, including $1,922,000 for station salaries and expenses; $241,500 for investigating atmospheric phenomena, and $31,500 for frost-warning investigations.

Bureau of Animal Industry $10,658,970, including $5,964,000 for indemnities and administrative expenses in eradicating tuberculosis; $712,390 for eradicating cattle tick; $429,170 for animal husbandry; $451,320 for eradicating hog cholera; $162,760 to combat diseases of animals, and $26,970 for eradicating dourine.

Bureau of Dairy Industry, $495,094; Bureau of Plant Industry, $3,914,585; Forest Service, $8,590,834; Bureau of Chemistry, $1,115,005; Bureau of Entomology, $3,062,265; Bureau of Biological Survey, $1,017,020; Bureau of Public Roads, $457,170 for administration expenses, road management, investigating road building and farm irrigation and engineering; Bureau of Agricultural Economics, $4,981,251; Bureau of Home Economics, $127,244; Federal Horticultural Board, $812,510.

Packers and Stock Yards Act, enforcement, $420,000; Grain Futures Act, enforcement, $135,000; food, drug and insecticide, enforcement, $1,311,385.

Cooperative forest-fire protection, $1,000,000; cooperative farm forestry, $60,000; cooperative distribution of forest planting stock, $75,000; acquisition of additional forest lands, $1,000,000.

Experiments in dairying and live-stock production in western United States, $41,610; establishment of Mandan (North Dakota) Experiment Station, $25,000; farmers seed grain loans collection, $10,000; eradication of foot and mouth diseases of animals, $100, besides unexpended appropriations.

SCIENTIFIC NOTES AND NEWS

DR. MICHAEL I. PUPIN, professor of electromechanics in Columbia University, will give the address of the retiring president of the American Association for the Advancement of Science at the opening general session on the evening of Monday, December 27, his subject being "Fifty Years' Progress in Electrical Communication." Preliminary announcements of the programs of the fifteen sections of the association and the thirty-nine associated societies, meeting next week in Philadelphia, will be found in the issue of SCIENCE for December 3.

DR. WILLIAM DAVID COOLIDGE, assistant director of the research laboratory of the General Electric Company, has been awarded the Edison medal for 1926, by the Edison committee of the American Institute of Electrical Engineers, "for the origination of ductile tungsten and the fundamental improvement of the X-ray tube."

DR. W. H. HOFFMANN, of the Finlay Laboratory, Havana, has been elected a member of the Halle Academy of Sciences.

THE National Geographical Society has elected Dr. Knud Rasmussen to honorary life membership in honor of his achievements in the north. Major General A. W. Greely, U. S. A., dean of living Arctic explorers, made the presentation.

LIEUTENANT COMMANDER RICHARD E. BYRD, the first airman to reach the North Pole, was presented with the highest medal of honor bestowed by the Geographical Society of Philadelphia, at a dinner of the society on December 15, when he was presented with the Elisha Kent Kane Medal.

THE University of Paris at a meeting on November 6 conferred honorary degrees on Dr. Carlos Chagas, director of the Oswaldo Cruz Bacteriological Institute, Rio de Janeiro, and Charles E. Guye, professor of physics at the University of Geneva.

THE honorary degree of doctor of science has been conferred by the University of Manchester upon Professor A. C. Seward, professor of botany in the University of Cambridge.

WE learn from *Nature* that the council of the Royal Anthropological Institute has decided that two Rivers Memorial Medals shall be granted for the year 1926. Of these one has been awarded to Professor Edward Westermarck in recognition of his researches on the customs and beliefs of the natives of Morocco. The other has been awarded to Dr. Alfred P. Maudslay in recognition of his work of archeological exploration in Central America.

AT the annual general meeting of the Royal Geological Society of Cornwall at Penzance, held on November 25, the William Bolitho gold medal was presented to Dr. R. H. Rastall for his researches in the geology of ore deposits.

THE Royal Society of Edinburgh has awarded its Keith prize for the period 1923–25 to Professor H. W. Turnbull, of St. Andrews, for his papers on hyperalgebra, invariant theory and algebraic geometry.

PROFESSOR N. E. NÖRLUND, of the University of Copenhagen, has been elected a corresponding member of the Paris Academy of Sciences in the section of geometry, as successor to the late C. Guichard.

DR. GOTTLIEB HABERLANDT, emeritus professor of plant physiology at the University of Berlin, recently celebrated the fiftieth anniversary of his doctorate.

DR. KARL F. KELLERMAN, associate chief of the U. S. Bureau of Plant Industry, has been obliged to resign from the organizing committee for the International Congress of Soil Sciences owing to a serious operation from which he is now recovering.

JAMES H. MCGRAW, president of the McGraw-Hill Publishing Company, was the guest of honor at a dinner in the Hotel Astor on December 12, given under the auspices of a committee to signalize his forty years of service as a publisher for engineering and industrial periodicals.

DR. EDWARD R. WEIDLEIN, director of the Mellon Institute of Industrial Research, University of Pittsburgh, was elected president of the American Institute of Chemical Engineers for the year 1927 at the recent annual meeting in Birmingham, Alabama.

THE New York section of the American Chemical Society has elected officers for 1927 as follows: Professor Arthur W. Thomas, of Columbia University, *chairman;* Dr. Charles R. Downs, consulting chemist, *vice-chairman,* and D. H. Killeffer, associate editor of *Industrial and Engineering Chemistry, secretary-treasurer.*

G. L. A. RUEHLE, assistant professor and research associate bacteriologist in the Michigan Experiment Station, has entered upon his duties as bacteriologist at the Idaho Agricultural Experiment Station, succeeding Dr. William M. Gibbs.

DR. LOUIS GROSS has been appointed acting director of laboratories at Mount Sinai Hospital; Dr. Gregory Shwartzman, bacteriologist; Michael Heidelberger, chemist, and Dr. Paul Klemperer, pathologist. The hospital announces that alterations are being made to accommodate a complete full-time staff in the laboratories.

JOSEPH R. LORENZ has joined the staff of Skinner, Sherman and Esselen, Inc., Boston, for the purpose of organizing a department of leather chemistry to render research, analytical and advisory service for tanners.

AT the Storrs Agricultural Experiment Station, Connecticut, leave of absence has been granted to Dr. L. C. Dunn, geneticist, who will spend a year abroad; to G. C. White, dairy husbandman, for a year's study in part at Columbia University, and to B. A. Brown, agronomist, for three months' study at the University of Wisconsin.

DR. AARON ARKIN, formerly professor of pathology and bacteriology in the School of Medicine of West Virginia University, has returned from a three years' stay in Vienna and Berlin, where he devoted himself to study and research in internal medicine. Dr. Arkin will specialize in internal medicine in Chicago.

W. M. COATES, instructor in mathematics at the University of Michigan, has returned after two years' study of aeronautics in Germany and Austria.

DR. SELIG BRODETSKY, professor of applied mathematics at the University of Leeds, arrived in New York on December 13. Dr. Brodetsky is one of the governors of the Hebrew University of Jerusalem and while in this country he will make a tour in the interests of the university.

DR. E. L. TAYLOR, a member of the Royal College of veterinary surgeons of England, has been detailed by the British Ministry of Agriculture to the zoological division of the U. S. Bureau of Animal Industry for a year's investigation of parasites of livestock, and he is now engaged in this work.

DR. M. MIYAJIMA, of the Kitasato Institute, and C. Ishikawa, former professor in the Tokyo Imperial University, left Yokohama on October 16 for New York, where they will work at the Rockefeller Institute.

THE Franklin Institute announces the first of a series of Christmas week lectures for young people, to be given by Professor Robert W. Wood, of the Johns Hopkins University. The subject is "Recreations with Radiations" and the lectures will be given in the hall of the institute at three o'clock on the afternoons of Monday, Tuesday, Thursday and Friday, of the week following Christmas.

DR. ELLIOTT P. JOSLIN, of Boston, gave the third annual Scripps Metabolic Clinic lecture before the San Diego County Medical Society on November 18, when he discussed the "Outlook for the Diabetic."

PROFESSOR JAMES KENDALL, of the department of chemistry of Washington Square College, New York University, delivered his presidential address before the New York chapter of the American Institute of Chemists at the Chemists' Club on October 29, the subject of his lecture being "New Separations by the Ionic Migration Method."

DR. WALTON MARTIN, professor of clinical surgery, Columbia University College of Physicians and Surgeons, will give the Mütter lecture, December 10, at the College of Physicians, Philadelphia, on "Hepatitis and Jaundice."

DR. ALFRED E. COHN, of the Rockefeller Institute for Medical Research, gave a public lecture on November 15 at the School of Hygiene and Public Health, the Johns Hopkins University, Baltimore, on "Heart Disease from the Point of View of the Public Health."

DR. A. P. LINK, instructor in psychology at New York University, addressed a meeting of the New York Electrical Society on December 15 on "Psychology, Crime and Jobs."

THE Medical Society of Nova Scotia has decided to celebrate the jubilee of the graduation of Dr. John Stewart by establishing at Dalhousie University a chair of surgery to be called by his name and for which purpose it is proposed to raise $50,000.

PORTRAITS of Dean F. E. Turneaure, of the College of Engineering, and former Professor Storm Bull, of the steam and gas engineering department of the University of Wisconsin, have been completed by Professor Carl Marr, of Munich, Germany, and will soon be formally presented to the college of engineering by professors and alumni of the college.

DR. FRANK HALL KNOWLTON, since 1907 geologist for the U. S. Geological Survey, died recently at the age of sixty-six years.

DR. GEORGE E. NESOM, former chief of the U. S. Bureau of Agriculture in the Philippines and sugar and live-stock expert at Louisiana State University and in Honduras, died on December 15, aged fifty-six years.

WILLIAM MARC CHAUVENET, consulting chemist and mining engineer, has died at the age of seventy-one years.

DR. ALBERT EDWARD HALSTEAD, professor of surgery at the University of Illinois and formerly head of the department of anatomy at the Chicago Medical College, died on December 6, aged fifty-eight years.

DR. SAMUEL GILBERT WEBBER, formerly instructor in nervous diseases at Harvard Medical School and for several years professor of neurology at Tufts Medical School, has died in his eighty-eighth year.

CHARLES HEDLEY, scientific director of the Great Barrier Reef Investigation Committee, of Australia, and formerly keeper of collections, Australian Museum, died on September 14, aged sixty-four years.

DR. KARL EBERTH, professor of histology and pathological anatomy at the University of Halle, Germany, discoverer of *Bacillus typhosus*, has died, aged ninety-one years.

THE two hundredth anniversary of the death of Sir Isaac Newton occurs on March 20, 1927. *Nature* states that a meeting to celebrate the event will be held under the auspices of the Yorkshire branch of the Mathematical Association at Grantham, near which Newton was born, and where he went to school. The program includes a scientific meeting on March 19, to be addressed by Sir J. J. Thomson, master of Trinity College, Cambridge; Sir Frank Dyson, astronomer royal; Dr. J. H. Jeans, Prof. G. H. Hardy, and Dr. Horace Lamb, who will speak about Newton's work in physics, astronomy, mathematics and mechanics. On the same day there will be a pilgrimage to the house at Woolsthorpe where Newton was born, and a visit to Stoke Rochford. In the evening there will be a dinner at the George Hotel, Grantham, among the speakers at which will be Professor E. T. Whittaker, Professor H. H. Turner and other distinguished men of science. A bicentenary sermon will be preached at the Parish Church, Grantham, on Sunday, March 20, by the Bishop of Birmingham.

ACCORDING to the *Journal* of the American Medical Association a committee to celebrate the centenary of Lister's birth has been formed in Edinburgh. As the annual meeting of the British Medical Association will be in that city, it has been decided to make the celebration coincide with it. A prize of $125 and a gold medal will be offered for the best essay on "The Influence of Lister on the Evolution of Surgery." The competition will be open to medical students of the schools in the British Empire and graduates of not more than one year's standing. A book on Lister's life and writings is being prepared. Addresses will be given by Lister's old assistant, Sir William Watson Cheyne; Professor Tuffier, Paris; Dr. Harvey Cushing, Boston; Professor Caird, Edinburgh, and Mr. Hamilton Russell, Melbourne. A museum containing relics of Lord Lister's life and work is being formed.

THE Physical Society of Pittsburgh has had the following meetings this autumn: October 14, "The Recent Eclipse of the Sun in Sumatra," Dr. H. D. Curtis, director of the Allegheny Observatory; November 11, "Magnetic Properties of Thin Films of Iron, Cobalt and Nickel," Dr. A. J. Sorensen, of the Union Switch and Signal Company; December 9, "The Hydrogen Molecule and its Relation to the Quantum Theory," Dr. Elmer Hutchisson, of the University of Pittsburgh. The Physical Society of Pittsburgh consists of about one hundred physicists, engineers, astronomers and mathematicians in the Pittsburgh district. The present officers of the society are: *President*, Dr. H. D. Curtis, Allegheny Observatory; *vice-president*, Dr. J. J. Weigle, University of Pittsburgh; *secretary*, Dr. J. B. Nathanson, Carnegie Institute of Technology.

A SERIES of six popular lectures on chemistry will be broadcast from Station WLWL by the members of the department of chemistry of the College of the City of New York as follows: January 18, "Gaseous Gasoline," by Dr. Reston Stevenson; January 25, "The Relations of the College Chemistry Department to the Students' Health," by Dr. W. L. Estabrooke; February 2, "Modern Science of Chemistry," by Dr. Martin Meyer; February 9, "Romance of Steel," by Dr. Martin Meyer; February 16, "Chemistry and the Automobile," by Dr. Joseph A. Babor; February 23, "Chemistry of the Kitchen," by Dr. Joseph A. Babor.

TWO offers, one of $50,000 to any person or group of persons who may discover what human cancer is and how it can positively be prevented, and another of like sum to the person or group of persons who may discover an absolute cure for the disease, have been made by William Lawrence Saunders, who is chairman of the board of directors of the Ingersoll-Rand Company. The offers were made in a letter to Dr. C. W. B. Crane which was read on December 15, at a dinner in the interest of the American Society for the Control of Cancer at the Hotel Biltmore, New York. The offer stands for three years, and at the expiration of that time may be renewed.

THE St. Louis College of Pharmacy has opened a campaign to raise $300,000 to erect a new building, and to establish a medicinal plant garden. It has already received a gift of $50,000 from William R. Warner and Company, manufacturing pharmacists, St. Louis and New York, and $25,000 from the Lambert Pharmacal Company, St. Louis.

AT the meetings in Philadelphia a joint symposium on "Greenland" will be participated in by section E (geology and geography) of the American Association for the Advancement of Science, the Association of American Geographers and the American Meteorological Society. The program is to begin at 10 o'clock on Thursday, December 30, in Logan Hall of the University of Pennsylvania. Papers will be presented by W. H. Hobbs, S. P. Ferguson, W. Elmer Ekblaw, Charles F. Brooks and A. J. Henry. There will be discussion by Isaiah Bowman, G. T. Rude and others.

THE Society of American Foresters has issued the report of a committee appointed by its Washington, D. C., section, entitled "A National Program of Forest Research," which outlines in detail the need and possibilities for acceleration in the development of forest research in this country. The report was prepared by Earle H. Clapp, assistant forester of the U. S. Forest Service, as chairman of the committee, which is composed also of A. B. Hastings, formerly assistant forester of Virginia, and R. C. Hall, until recently valuation engineer in the timber section of the Bureau of Internal Revenue. The report has been published for the society in book form by The American Tree Association.

THE Charles Pfizer Company of New York, manufacturers of citric acid and its salts, has established a $3,000 fellowship in the College of Agriculture at the University of Wisconsin. It has been allocated to the dairy department where, under the direction of Professor H. H. Sommer, studies will be continued on the effect of milk salts, and particularly sodium citrate, on the whipping ability of ice cream mixers. Dr. H. L. Templeton, following his resignation from the staff of the Forest Products Laboratory, has been appointed to carry on this work.

THE vice-chancellor of the University of Cambridge has published a communication received from the committee of the Privy Council for Scientific and Industrial Research, stating that funds have been placed at their disposal by the Empire Marketing Board which will enable them to offer a further grant not exceeding £25,000 to the university for the building and equipment of an extension of the low temperature research station.

A LARGE collection of Pliocene fossils has been secured by the second Captain Marshall Field paleontological expedition to Argentina, according to an announcement by Elmer S. Riggs, associate curator of paleontology at the Field Museum, and leader of the party. The Field Museum representatives are engaged on the property of Provincial Senator Carmen Aybar, in Catamarca. They are the first paleontologists to work this area.

A DISPATCH to the New York *Sun* states that in anticipation of a circular flight around the north pole by dirigible, under the auspices of the nations which participated in the recent polar congress at Berlin, the Soviet government has started preparations for a scientific observatory on Novo Sibirsk Islands, 75 degrees north latitude and 140 degrees east longitude. Professor Roman Samoilovitch, director of the Soviet Institute for Investigating the Arctic Regions, says the flight will start from Leningrad and will proceed by way of Murmansk to the Novo Sibirsk Islands.

UNIVERSITY AND EDUCATIONAL NOTES

THE $5,000,000 mark has been passed in the campaign to add $20,000,000 to the endowment for teaching at Yale University, in advance of a general appeal to the alumni, according to a statement made by President James R. Angell.

AMONG public bequests made by the late Julius Levy, of Baltimore, is $50,000 for the Johns Hopkins University. The income from one half is to be used for general purposes and from the other half for the medical school.

IT is announced that a new junior college for women, to be known as the Sarah Lawrence College, has been established at Bronxville, N. Y., through a gift of approximately $1,250,000 by W. V. Lawrence, of Bronxville.

THE four residuary legatees under the will of the late David Hale Fanning will each receive between $100,000 and $150,000. They are the Worcester Polytechnic Institute, Hahnemann Hospital, Connecticut College for Women and Talladaga College, Alabama. These sums are in addition to the $25,000 which each was given outright under the will.

DR. W. L. MACHMER, of the department of mathematics at the Massachusetts Agricultural College, has been made dean of the college.

DR. L. J. POLLOCK, of New York, has been appointed head of the department of neurology at the Northwestern University Medical School.

DR. VERNON L. MANGUN, formerly head of the North Dakota School of Forestry at Bottineau, has become professor of education in the University of New Hampshire.

DR. ALBERT SALATHE, formerly on the faculties of Union College and of Centenary College, has been appointed associate professor of chemical engineering at Syracuse University.

DR. B. Z. LINFIELD has been appointed associate professor of mathematics at the University of Virginia.

DR. W. S. PATTON, formerly director of the King Institute of Preventive Medicine, Madras, India, has been appointed to the Dutton memorial chair of entomology at the University of Liverpool.

M. LUTAUD has been appointed professor of physical geography at the University of Paris to fill the vacancy caused by the death of Professor L. Gentil.

DISCUSSION AND CORRESPONDENCE

THE SEMI-CENTENARY OF WILLARD GIBBS' PHASE LAW (1876–1926)

THE issue of the *Chemisch Weekblad,* of September 18, 1926, published by the Netherlands Chemical Society, is of particular interest to American scientists. Thanks to the interest in the history of science by the editor of that periodical, Dr. W. P. Jorissen, at Leyden, we are reminded in these pages of what science owes to Josiah Willard Gibbs, who occupied the chair of mathematical physics at Yale from 1871 until his death in 1903.

Doubtless this man has been the greatest scientific genius produced by the United States of America. His paper "On the Equilibrium of Heterogeneous Substances," published in 1876 in the Proceedings of the Connecticut Academy, has not only governed to a great extent the development of chemistry since 1886 but it has also included a program for the future. When J. D. van der Waals at Amsterdam had grasped the deep significance of Gibbs's work and after he had drawn Bakhuis Roozeboom's (then in Leyden, later in Amsterdam) attention to its importance, the phase law was very readily developed. Almost all branches of chemistry to-day are reaping the fruits of the accomplishments of this deep genius of New Haven, who through his modesty was so little known even to his countrymen.

The detailed treatment of this part of the history of science would yield a most fascinating narrative, full of variety and stimulation to our future generations. Not only this issue of the *Chemisch Weekblad* and the list of books and pamphlets on the phase law and its applications added to it by Dr. Jorissen but also Donnan's discourse held in September, 1924, on the occasion of the centenary celebration of the founding of the Franklin Institute, as well as Lash Miller's paper in the *Chemical Reviews* (January, 1925), would supply abundant material. The jubilee issue of the *Chemisch Weekblad* commemorates at the same time the fact that twenty-five years ago F. A. H. Schreinemakers, to whom the development of the phase law owes so much, was appointed a professor in the University of Leyden.

After a short historical introduction of W. P. Jorissen, Henry Le Chatelier (Paris) gives a paper on "L'oeuvre de J. Willard Gibbs." Wilhelm Ostwald (Grossbothen, Germany) informs us why he translated Gibbs's papers into German. J. D. van der Waals, Jr. (Amsterdam), son of J. D. van der Waals, treats Gibbs's influence on the theory of mixtures; W. Lash Miller (Toronto) "The Fundamental Equation of Willard Gibbs." F. A. H. Shreinemakers expresses his gratitude and deep appreciation towards his friend and teacher, Bakhuis Roozeboom, who passed away too soon; Gustav Tammann (Göttingen) gives us an insight into the development of metallurgy. Norway is represented by J. H. L. Vogt (Trondhjem) who pictures the significance of Gibbs's life work for petrography, and J. J. van Laar (Holland) gives a paper on a "Limiting Case in Phase Equilibria." J. W. Terwen (Delft, Holland) calls our attention to the significance of the phase law to the study of allotropy; F. G. Donnan (London) to the influence of Gibbs's work on industry.

The issue closes with a paper of F. A. Freeth (Hartford, England) on "The Scientific Work of F. A. H. Schreinemakers" and Miss W. C. de Baat's (Leyden) personal reminiscences of the time during which Schreinemakers was a professor at Leyden.

The whole issue of the *Chemisch Weekblad* (illustrated with seven portraits) may be considered as a publication worthy of the man to whose genius science is so deeply indebted.

ERNEST COHEN

ANN ARBOR, MICH.
NOVEMBER, 1926

SECOND ORDER STARK EFFECT IN HYDROGEN

THROUGH the kindness of Dr. T. Takamine, I received some information about very accurate experimental determinations of the second order Stark effect in hydrogen, carried out by Professor M. Kiuti. Unfortunately this material came too late to be used in my article on the Stark effect (*Phys. Rev., 28,* p. 695, 1926), therefore, I should like to make these beautiful observations available to a larger public through the agency of SCIENCE.

Professor Kiuti measured the shift of the central ⊥ component of Hγ in very strong electric fields and obtained the following results:

(1) Result of most recent experiments:

Field	Shift	Shift reduced to 100,00 volt/cm
140,000 volt/cm	.64 Å	.33 Å
156,000 "	.67 "	.28 "

(2) Result of previous experiments (*Japanese Journal of Physics, 4,* p. 13, 1925):

Field	Shift	Shift reduced to 100,00 volt/cm
95,000 volt/cm	.35 Å	.39 Å
103,000 "	.33 "	.31 "
107,000 "	.39 "	.34 "
124,000 "	.57 (?)	.33 (?)
161,000 "	.67 "	.26 "

(3) Professor Kiuti makes the following remarks:

(a) It appears that the effect is rather large at weaker fields, so that it is possible that the shift is not quite proportional to the square of the field. However, the degree of accuracy of these measurements does not permit to assert it definitely.

(b) The weighted means of the most reliable observations is

Field	Shift
100,000 volt/cm	0.28 Å

(c) The field was here calculated theoretically. If Stark's value is extrapolated, the field becomes 5 per cent. less, increasing the shift in the same proportion.

In order to compare Professor Kiuti's measurements with our theory, it will be necessary to compute the theoretical shift more accurately than it has been done heretofore. The formula given in my paper (*l. c.*) for the shift is

$$\Delta_2\lambda = \frac{D^2\lambda^2}{16\mu^3 hc}\left(\frac{h}{2\pi e}\right)^6 [S(m, n, s) - S(m', n', s')],$$

$$(1)\quad S = (m+n+s)^4\,[17(m+n+s)^2 - 3(m-n)^2 - 9s^2 + 18s + 10].$$

D is the strength of field, m, n, s are quantic integers, while the rest of the symbols are used in the customary sense. Substituting the most accurate available values of μ, e, h, we find the numerical factor

$$(2)\qquad \Delta_2\lambda = 5.16 \cdot 10^{-18}\, D^2\lambda^2 (S - S'),$$

if D is expressed in kilovolt/cm, λ in Å.

The component observed by Professor Kiuti is in reality a superposition of two lines. The first is given by the quantic numbers $m = n = 1$, $s = 3$; $m' = n' = 0$, $s' = 2$, the second by $m = n = 2$, $s = 1$; $m' = n' = 0$, $s' = 2$. Accordingly, the first gives the shift 0.246 Å, the second 0.268 Å. The first line is responsible for 81 per cent. of the total intensity, while the share of the second is 19 per cent. We obtain, therefore, for the center of gravity the shift

$$\Delta_2\lambda = 0.251 \text{ Å}.$$

This is the theoretical value in the new theory which must be compared with 0.28 Å found by Professor Kiuti experimentally.

It is interesting to compute the values resulting from our old theory (*Ann. der Phys.*, 51, p. 168, 1916) with the same accuracy. The only difference is in the expression of the function S: the terms $18s + 10$ in formula (1) must be omitted. We obtain the following results: Shift of the first line 0.208 Å, shift of the second line 0.252 Å, shift of the center of gravity

$$\Delta_2\lambda = 0.217 \text{ Å}.$$

We see that the experiments agree decidedly better with the new theory than with the old one. Perhaps the accuracy of the observations is not yet sufficient to make the decision in favor of the new theory conclusive. It seems, however, that such a decision is well within the reach of experimental possibilities.

PAUL S. EPSTEIN
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UNUSUAL CARBONIFEROUS CEPHALOPODS

TEXT-BOOKS of geology point to the Ordovician as the time of great development of the straight cephalopods and declare that "these predaceous masters of the sea attained a length of twelve to fifteen feet, and had a maximum diameter of twelve inches." They further indicate that, with the rise of coiled forms, orthoceracones waned rapidly, although they were still common and relatively large in the Silurian, and not unknown in the Devonian. Carboniferous orthoconic cephalopods, however, are reputed to be rare and invariably small. That this is not always the case is evidenced by the discovery of large orthoconic forms in the Fayetteville shale of Arkansas, a formation of upper Mississippian (Chester) age. These fossils, which recently have been described in detail by the writer,[1] are remarkable for several reasons.

In the first place, they attained a length of at least four feet and must have had a diameter of ten inches. *R. solidiforme,* the holotype of the new genus *Rayonnoceras* (M. C. Z., No. 2326–30) has a diameter of six inches *posterior* to the living chamber, while another specimen, in the University of Arkansas Museum, has a diameter of nearly eight inches, *although the shell is still septate.* An ordinary collection of specimens of species of *Rayonnoceras* will contain individuals as large or larger than those in the usual Ordovician group of cephalopods. An examination of the literature shows that in only one other case have large straight cephalopods been discovered in the Carboniferous. Sowerby[2] described *Orthoceras gigantea* from the red limestone of Castle Espie, Ireland, as attaining a length of two feet. McCoy[3] later described the same species as *Actinoceras giganteum,* and reported its maximum (reconstructed) length as four feet. With the exception of this Irish species, no other Carboniferous cephalopod even approaches the Fayetteville specimens in size. There are also cases where orthoconic Carboniferous

[1] Croneis, C., *M. C. Z. Bull.*, LXVII, No. 10. (1926.)
[2] Sowerby, *Min. Conch.*, 81. (1818.)
[3] McCoy, *Carb. Fos. Ire.*, 11. (1844.)

forms of at least medium size are common. The Caney shale of the Arbuckle Mountains of Oklahoma, for instance, is often very fossiliferous, and in places carries a fauna made up predominately of straight cephalopods. It is evident that orthoceracones of large size and in large numbers did live on into the Carboniferous in a few favored localities.

The Fayetteville cephalopods are remarkable in the second place because of their unique morphology and because they are well enough preserved to throw definite light on their unusual structure. Polished sections show that the animal did not completely abandon its posterior chambers when the body moved forward to occupy a new "living chamber." Furthermore, it is evident that the camerae were not air containers, but the loci of deposition of regular organic deposits, secreted by rayonnettes, or double membranes, which extended from the siphuncular wall to the shell of the animal at about the middle of each camera. Complete evidence for this statement is presented elsewhere,[4] but partial proof for the contention may be found in the fact that the holotype of the genus *Rayonnoceras* is a conch which was broken in two and recemented during the life of the individual. If the cephalopod did not maintain organic connection with its camerae, this remarkable circumstance is very hard to explain.

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A PARASITE OF THE GOLD-FISH

A SHORT time ago Mr. Guy Mason, of Boulder, Colorado, sent me a parasitic crustacean which he had found on the gills of one of his gold-fish (*Carassius auratus*). It is broad oval, about 4.5 mm. long, with a pair of round adhesive discs on the under side. The tail is deeply notched, and is marked with a pair of black dots. The gold-fish was bought in Denver. The species proves to be *Argulus trilineatus* C. B. Wilson, well described and figured in Proc. U. S. Nat. Museum, XXVII (1904) p. 651. Wilson had a single female, found on a gold-fish at Macon, Georgia. My specimen is also a female. The name *A. trilineatus* is perhaps not quite appropriate, as my specimen shows the same pigment spots, but more numerous than in Wilson's figure and distributed along each side of a clear line. On each side of the line there is a certain tendency for the spots to be in two rows, and Wilson's figure apparently shows that his animal also had four rows of spots. The species presumably came from Europe, and it is in fact very similar to the European *Argulus coregoni* Thorell. Those who have gold-fish should be on the lookout for this curious crustacean which may prove to be commoner than the scanty records indicate.

Wilson writes *A. trilineata,* but the name *Argulus* is of masculine gender and is elsewhere so treated by Wilson himself.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO,
BOULDER, Nov. 18, 1926

[4] *Loc. cit.,* 345.

A CONTEMPORARY OF CHARLES DARWIN

A LETTER has recently been received from an English lady, Mrs. Arabella B. Fisher, who as Miss Arabella B. Buckley, at the age of twenty-three, served as secretary to Sir Charles Lyell. At that time Miss Buckley undoubtedly wrote many of the letters which passed between Lyell and Darwin.

The writer recently received a special request from Mrs. Fisher for a reprint of his address at Oxford entitled "The Problem of the Origin of Species as it appeared to Darwin in 1859 and as it appears to us to-day," as recently printed in SCIENCE. Mrs. Fisher's letter of acknowledgment shows that the Oxford address was successful in expressing almost complete dissent from Darwin's original statement without offending the old friends and supporters of the great naturalist:

> Thank you most heartily for sending me your article on "The Problem of the Origin of Species" at the request of Miss Allen.
>
> I am now an old woman 86 years of age, but I was a young girl of 23 when, as secretary to Sir Chas. Lyell, I first met Mr. Darwin and was encouraged by him to write on animal life for children. I had the privilege of visiting him and Mrs. Darwin at Down until his death in 1882.
>
> I revered him not only for his work but for his noble character, and was somewhat pained by the reaction against natural selection in the struggle for existence exhibited by some English and American zoologists after his death. As I married and lived in the depth of the country not long afterwards I only got second hand information as to recent advances in knowledge on these points.
>
> Therefore when I saw the short account in the *Times* of your address at the British Association this year I welcomed even such scanty information as it contained, and longed for the article itself.
>
> I give you these personal details as it will show you how I value your impartial account of recent investigation, and your appreciation of how the foundations of the theory itself were "really and truly laid" so far as the knowledge of that time permitted.
>
> Thanking you again most sincerely.
>
> Yours truly,
>
> (Signed) ARABELLA B. FISHER
> (née Buckley)

This letter will be added to the growing collection of Darwiniana in the American Museum of Natural History.

HENRY FAIRFIELD OSBORN
AMERICAN MUSEUM OF NATURAL HISTORY

SCIENTIFIC BOOKS

Our Mobile Earth. By REGINALD A. DALY. New York, Charles Scribner's Sons, 1926.

THIS book, "boldly planned on an endlessly difficult theme," is primarily intended for the general reader; even so, working geologists and especially teachers of the earth sciences will find "Our Mobile Earth" not only replete with facts but also interesting, and inspirational to deep thinking. The earlier chapters abound in short sentences, and in questions that are answered directly with examples and striking illustrations; toward the end, however, as the subject-matter becomes more difficult, the book becomes somewhat heavy reading. It goes easily from the known to the unknown, and finally becomes highly speculative, and why not, since "science progresses through systematic guessing in the good sense of the word"? Daly has made clear in this book many of the profound problems now so actively discussed by geologists and geophysicists everywhere, as to why the earth has high standing continents, vast oceanic basins, mountain chains, volcanoes and earthquakes.

Daly's theme, as his title shows, is the mobility of the earth's surface. This mobility is expressed in earthquakes, volcanic action, broad warpings of the crust, rising of mountains and subsiding of oceanic basins. The opening chapter is on "Great Earthquakes of History." The crust is under strain and at intervals it snaps and moves a little—"each snapping means an earthquake." Between 1885 and 1903, the seismographs of Japan recorded four earthquakes per day, while for the whole earth there is nearly one for each hour. Fortunately, however, most of them are on the oceanic bottoms. The following chapter on the "Nature of Earthquakes" makes it plain that our city fathers should above all study seismology and human psychology, for this knowledge is "to the millions of the future more precious than rubies."

These two stirring chapters lead naturally to a study of "The Earth's Interior," and thence into another striking chapter on volcanic action. The rigid crust, composed of crystallized granite and basalt, is, we learn, "about forty miles thick," and it rests upon a hot, easily yielding and uncrystallized substratum of basalt. This substratum is "potentially mobile" and in consequence gives rise to "the possibility of volcanic action, and of mountain chains." The granitic continents, of lighter materials, actually float on the heavier basalt of the substratum, just as an iceberg does in sea water. From the substratum rise, through great cracks in the crust, the materials extruded by the volcanoes. Furthermore, as the earth is a shrinking mass, due to loss of heat, to loss of material to the exterior (gases and rocks), and to compression, naturally the cold and rigid crust must also shrink, and it does so through folding, crumpling and overriding of masses. It is due to these internal changes that the face of our earth is mobile and has taken on, through the further action of erosion, the expression we see all about us.

Mainly through earthquake shocks and the resulting tremors or waves that travel rapidly around and through the earth, geologists have learned that the material of the earth is in layers or shells: at the center is the core of iron, making one sixth of the earth's mass; this is overlain by the transition shell, eight hundred miles thick, in which rock materials are introduced; and then follows the silicate shell, one thousand miles thick, in which the amount of iron becomes less and less, and which is in turn enclosed by the crust of the earth, about forty miles thick.

We are now prepared to understand the "Distortion of the Earth" and why there are mountain ranges, and then we are instructed as to the origin of these mountain ranges. In the last-mentioned chapter the climax of the book is attained, but to round out the subject another chapter is added on the "Evolution of the Face of the Earth."

It has long been known that Daly sees much of value in the Taylor-Wegener hypothesis of continental drift, which is now being widely discussed. This hypothesis, he holds, "must be seriously entertained as the true basis for a sound theory of mountain building. . . . Taylor and Wegener believe that the mountain chains of the globe were formed by the horizontal crushing of geosynclinal prisms which lay in front of *slowly moving, migrating continents.*" Parts of the continents are bowed or raised up and accordingly gravitate downhill, as it were, over the potentially mobile substratum, and so by their sliding force crumple together the weaker places in the crust. As he says, "The continents appear to have slid downhill, to have been pulled down, over the earth's body, by mere gravity; mountain structures appear to be the product of enormous, slow *landslides.*"

"Our solid earth, apparently so stable, inert and finished, is changing, mobile and still evolving. . . . And the secret of it all—the secret of the earthquake, the secret of the 'temple of fire,' the secret of the ocean basin, the secret of the highland—is in the heart of the earth, forever invisible to human eyes."

CHARLES SCHUCHERT
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Rain-making and Other Weather Vagaries. By W. J. HUMPHREYS, meteorological physicist, United States Weather Bureau. Baltimore, The Williams & Wilkins Company. 150 pages. Price $2.50.

PROFESSOR HUMPHREYS has chosen as an appropriate title "Rain-making." In view of the knock-down, drag-out treatment accorded each and every method proposed, a more fitting title would be "The Improbability of ever making Rain by Human Agencies." But then no publisher would stand for that. A sub-title describes the work very well as a book on weather follies and fancies. Such it is, a most readable and entertaining book upon *pluviculture*. This name we owe to Dr. David Starr Jordan, who used it recently in SCIENCE, when analyzing the mental processes of prevaricating mortals, self-styled rain-producers. The breed infests the doctor's own great golden state—the realm of climate, glorious enough when the rains come in due season.

On the Pacific coast, we have known business men, seemingly sane and level-headed, hand over their tribute of shekels to fakirs claiming to produce rain sufficient to ensure a prosperous season. Now we ourselves are not noted for business acumen, yet it seems to us that a prosperous season would be a trifle more prosperous if shekels given to the undeserving were withheld.

Dr. Humphreys has a keen sense of humor. The book opens with a poem by the distinguished chemist-in-chief of the Geological Survey, Dr. Frank Wigglesworth Clarke. It appeared in *Life* thirty-five years ago; but like its author still retains the sprightliness of youth. It tells of Jones, the rain-maker who started the rain. But he did not know how to stop it. Help came at last.

> To check the flood, you started, I've heard
> All efforts were in vain;
> Until the Bureau at Washington stirred
> And stopped the storm with a single word,
> By just predicting Rain!

The valorous forecaster thus appears in a new light. When after a succession of rainy days the sun breaks forth, and we read the morning forecast—"Rain," we shall understand and appreciate the efforts of a self-sacrificing forecaster at headquarters.

After the geologist's "Rhyme of the Rain Machine," we are treated to ninety pages analyzing the various efforts made to control rain. There are numerous calculations of the amount of energy involved with cost estimates. These last would seem to be prohibitive; and the situation is perhaps best summed up in the words:

> One may do as he likes with a small bit of air entrapped in a bell jar, for instance, but the free atmosphere covering hundreds of square miles, and weighing billions of tons is hopelessly beyond human control.

In explaining droughts in the Valley of California during summer it is stated that because the incoming air is greatly warmed, its relative humidity is so reduced as to render precipitation by convection practically impossible. "If, for instance, the temperature of the lower air is 305° A. (90° F.) and the relative humidity 20 per cent., common conditions in such regions, cloud would not form as a result of convection, below about 3.25 kilometers. Hence a shower from these clouds is improbable; etc." There would be under such conditions about thirty-two grams of water vapor per cubic meter of space when saturated. If only 20 per cent., or six grams, were present, there would still be enough, we think, to condense as clouds, and under unstable conditions result in thunderstorms, if the usual lapse rates prevailed. And we do have, whenever the moisture is present, clouds and occasionally thunderstorms. The fact is, that the lower strata are robbed of their vapor at the upper end of the valley—evidenced in the fogs of the bay section and Lower Sacramento Basins, also the northern reaches of the San Joaquin. We should prefer to treat the aridity of the valley as due to actual removal of vapor at the source by condensation, rather than a loss due to warming and convective removal.

While essentially scientific, the book deals with efforts other than the purely physical or chemical to produce rain. There is much that is informative regarding magical and religious ceremonies.

Part II, of fifty pages, treats of the planets and weather, the moon and the weather, moon farming, key or control days, equinoctial storm, alleged weather omens of fauna and flora and certain miscellaneous follies. This part of the book would do an immense amount of good if widely circulated among the farmers of our country.

Notwithstanding that the Weather Bureau has been functioning for more than half a century and that in many colleges courses in meteorology are given, many minor newspapers publish horoscopes and planetary prognostics; and apparently intend to do so. Space given to such nonsense might be used to better advantage. It therefore is incumbent upon instructors in high schools and academies to interest their young people in the problems connected with cloudy condensation in the free air. No more helpful book than this one of Professor Humphreys's is to be found; and it will prove not only stimulating but extremely convenient in meeting many otherwise puzzling inquiries. The book is well printed, type work, com-

position, proofreading and make-up, all creditable. The publishers, following their usual custom, give the names of all who have contributed skill of hand or brain.

ALEXANDER MCADIE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

CEMENT CASTS OF PETROGLYPHS

CASTS of petroglyphs may be successfully made of cement. I do not recall having seen such casts in museums, although I have frequently visited the largest museums in Canada and the United States. When I suggested trying to reproduce a petroglyph from Kispiox, B. C., in cement an engineer of many years' experience told me that it could not be done without breaking my plaster of Paris mould and producing a cast damaged by numerous air bubbles.

On trying the experiment an ordinary plaster of Paris mould was used and not only the first cast but all three that were tried were satisfactorily successful. These casts were sent one to the Victoria Memorial Museum—the national museum of Canada—at Ottawa; another to the Vancouver museum, and the third to the United States National Museum, Washington.

The well-shellacked mould was soaped liberally and allowed to dry. The cement was mixed, one of cement to two of sifted fine sand, by my foreman, Mr. W. C. Washburn, of Kitwanga, B. C., who flowed it with a spoon from one edge of the mould over the entire surface. When the surface was covered to a depth of about a quarter of an inch wire netting was laid on and covered with cement or in the case of the last cast strips of wire and iron were laid on to form a reinforcing grid. A wire loop was laid in the cement and allowed to project at the back near the upper end of the cast to serve in hanging the cast on a wall.

The next day the cast was easily lifted out of the mould, having shrunk sufficiently to lift more easily than the usual plaster of Paris cast. It might be well to allow the cast to remain in the mould longer to insure safety from being broken in lifting. The result greatly resembled the original rock. Such casts may be painted with diluted oil or water colors or various colored sands and pigments may be used to make them resemble various colored rocks. The texture can be modified, by using coarser sand or mixtures of less cement or less sand, thus making the cast resemble coarser or finer rock. It is possible that other materials than soap may be used to make the cast separate from the mould. But difficulty may be encountered in representing rock of finer texture than pure cement or of color much lighter than cement. It may be more difficult to cast by this process petroglyphs or other archeological objects that are very large or are not as flat as the Kispiox specimen but experiments seem worth trying since the success of the method leads me to advocate cement in place of plaster of Paris for making casts of flat petroglyphs up to four or five square feet in area.

HARLAN I. SMITH

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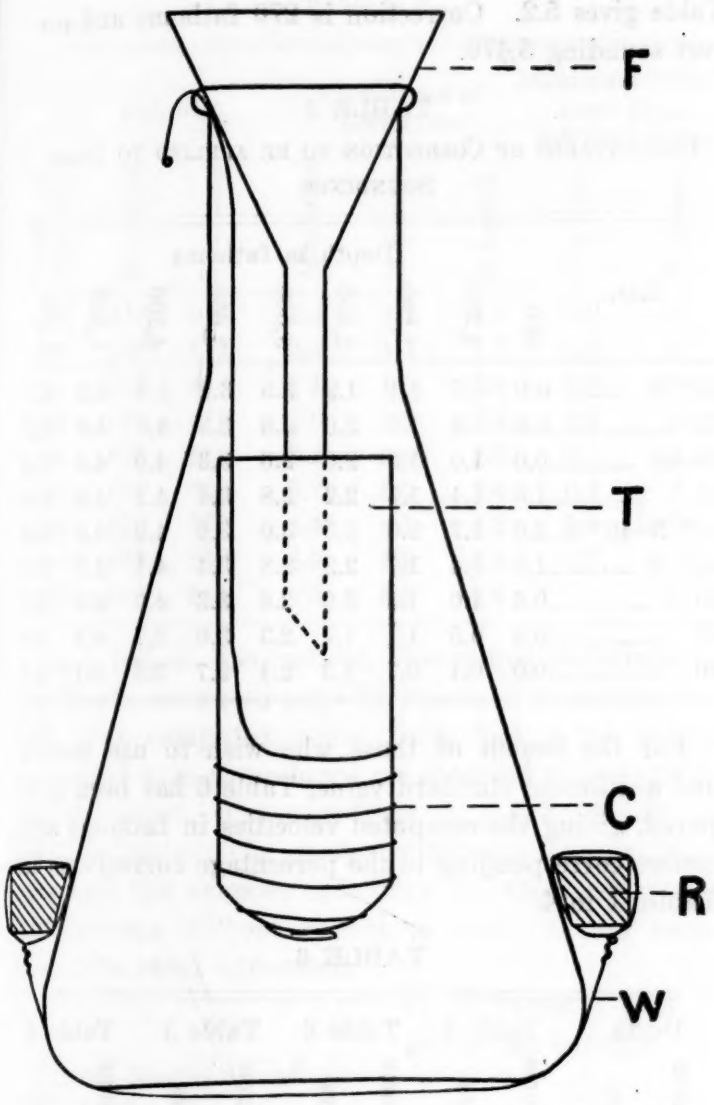
A SIMPLE DEVICE FOR EXTRACTION AND DIGESTION

THE Erlenmeyer flask is a convenient vessel for digestion of plant materials during their analysis. Although its equilibrium is rather unstable when set in water to any depth, this difficulty is overcome by a ring of lead, "R" as shown in the diagram, attached to the flask by a wire, "W," fastened to the ring at opposite sides and drawn taut under the bottom of the flask. The ring should be equal in weight to the total water displacement of the flask, and as shown in the diagram it should be located well below the normal center of gravity of the vessel. For extraction of substances where boiling temperatures are not permissible, the material can be placed in an ordinary thimble, "T." A piece of copper wire, partly wound into a coil "C" that is slightly larger than the thimble is lowered into the flask by the handle made from the unwound wire. A hook at the upper end of the handle slipped over the lip of the flask will hold the thimble above the liquid in the bottom. The funnel "F" inserted in the neck will serve to deliver the extracting liquid into the thimble, will act as a condenser for any that may evaporate and will keep the thimble upright if the coil is not sufficiently deep. For extractions by intermittent applications, when it is desirable to keep the extract away from the substance in the thimble, this apparatus has proved most satisfactory. Its cheapness and ready convertibility into a digester permits a large number of units to be put into operation at once, and with the coil and thimble removed the weighted flask makes an ideal vessel for sugar determination.

The chief advantages of the ring attachment to the flask when used as either an extractor or a digester lie in the safety and speed with which the flasks may be handled, in its compactness and in the elimination of clamps during all operations. The wire which keeps the ring firmly in place also raises the flask from the bottom of the bath and prevents superheating the material within.

This apparatus is especially useful as the digester



"F"—funnel. "T"—thimble. "C"—coil. "R"—ring. "W"—wire.

vessel for the reduction of Fehling's solution in a hot water bath. The handling of ordinary containers while hot during filtration is difficult and uncertain. Comfortable and safe manipulation of the flask by the ring "handle" is possible almost immediately after removal from the bath, if the flask is set into cold water, or held under the tap for a few seconds. Rinsing with hot water is accomplished with equal ease and safety. Nearly six hundred sugar determinations have been run without a single loss when this special "ringed flask" was used.

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SPECIAL ARTICLES

CORRECT VELOCITIES FOR ECHO SOUNDING IN THE PACIFIC OCEAN

SPECIAL Publication No. 108, United States Coast and Geodetic Survey, "Velocity of Sound in Sea Water," gives tables from which may be derived, by a method described in the publication, the proper velocity of sound to use in echo sounding, provided that the temperature and salinity of the water are known.

If we know the average annual conditions of temperature and salinity for any ocean for all depths, tables can be prepared which indicate regions throughout which the same velocities can be used for given depths without introducing material error. Determination of the extent of such regions and the velocities to be used in each is the purpose of this paper. The results show that the information can be given in a simple and easily used table for the entire Pacific Ocean.

Information as to mean annual temperature at the surface and at various depths was obtained from the publication "Die Warme Verteilung in den Tiefen des Stillen Ozeans" by Gerhardt Schott and Fritz Schu. The information was amplified from the Report of the Scientific Results of the Challenger Expedition, Physics and Chemistry, Vol. 1. Information regarding salinity was obtained from an atlas of thirty-one maps published by the Deutsche Seewarte in 1896 and from the Challenger report just mentioned.

For convenience, a map of the North Pacific was selected which gave the outlines of the land and meridians and parallels 10° apart. At each intersection the average temperature for each two hundred fathoms layer was entered and also the proper salinity to use, the same salinity being used for all depths. Seasonal changes of temperature were neglected, as these affect only the two upper layers and the second layer but slightly. While the variation of temperature at the surface during the season is considerable in the temperate zones, the average temperature of the upper layer does not vary much.

With the temperature and salinity fixed for each layer, the proper velocity for any desired depth was obtained from the tables of Special Publication No. 108, applying the adiabatic correction. The velocities were tabulated for 600 fathoms, 1,200, etc., to 5,400 fathoms, the greatest depth known.

The form of table adopted as most convenient was not a velocity table, but a percentage correction table. In practically all echo sounding now being carried on, all soundings are computed for a standard velocity and all that is needed is the correction to apply for the proper velocity. The percentage of correction to be applied is equal to the proper velocity divided by the standard velocity, minus one. Thus, if standard velocity is 800 fathoms per second and proper velocity is 824 fathoms per second, the percentage of correction is 3.0. The United States Navy and the Coast and Geodetic Survey have adopted the above

named standard velocity of 800 fathoms (4,800 feet) per second. So long as the standard velocity is less than any adopted proper velocity, the correction is additive.

The percentages of correction were compiled on a similar map to that used for temperature and salinity. The next operation was to determine the extent of the region for which the same table might be used without introducing appreciable error.

Inspection of the map showed that for all intersections from and including 30° N. to the equator there was little departure from the mean value for the entire region. Mean percentages of correction were adopted for each layer and the rule was adopted that in general the range of the corrected sounding should not exceed five fathoms on either side of the mean. Further inspection showed that for all intersections on parallels 40° and 50° N. a second table would suffice. A still different table was found necessary for the north part of Bering Sea, deep portion approximately in Lat. 60° N. These three tables with interpolation between them cover the entire North Pacific except the adjacent seas on the west side and the shoal portion of Bering Sea.

The area of the South Pacific was then examined, selecting the extreme conditions in each region. It was found that the table for the tropical region could be extended to 40° S.; that the table for 40–50° N. applies to 50° S. and that a fourth table was needed for 60° S. The tables follow:

Fathoms	Table 1 60° N	Table 2 50–40° N, 50° S	Table 3 30° N to 40° S	Table 4 60° S
600	0.0	0.6	2.0	0.0
1,200	0.5	1.0	1.7	0.1
1,800	1.1	1.5	2.0	0.7
2,400	1.9	2.0	2.5	1.5
3,000	2.5	2.6	3.0	2.1
3,600	3.2	3.3	3.6	2.7
4.200	3.9	4.0	4.2	3.5
4,800	4.5	4.6	4.9	4.1
5,400	5.1	5.2	5.4	4.7

In order that interpolation may be easy, and only one table be needed, the information has been rearranged in Table 5.

Examples of use of table: At 35° N., 140° W. an echo sounding of 2,923 fathoms was obtained using standard velocity. Interpolating in the above table we get correction percentage of 2.7. Correction is $29.23 \times 2.7 = 79$ fathoms. Correct sounding is 3,002 fathoms.

24° N., 141° E. unreduced sounding 5,200 fathoms. Table gives 5.2. Correction is 270 fathoms and correct sounding 5,470.

TABLE 5

PERCENTAGES OF CORRECTION TO BE APPLIED TO ECHO SOUNDINGS

Lat.	Depth in fathoms 600	1,200	1,800	2,400	3,000	3,600	4,200	4,800	5,400
60° N	0.0	0.5	1.1	1.9	2.5	3.2	3.9	4.5	5.1
55	0.3	0.8	1.3	2.0	2.6	3.2	4.0	4.6	5.2
50–40	0.6	1.0	1.5	2.0	2.6	3.3	4.0	4.6	5.2
35	1.3	1.4	1.7	2.2	2.8	3.4	4.1	4.8	5.3
30° N–40° S	2.0	1.7	2.0	2.5	3.0	3.6	4.2	4.9	5.4
45° S	1.3	1.4	1.7	2.2	2.8	3.4	4.1	4.8	5.3
50	0.6	1.0	1.5	2.0	2.6	3.3	4.0	4.6	5.2
55	0.3	0.5	1.1	1.7	2.3	3.0	3.7	4.3	4.9
60	0.0	0.1	0.7	1.5	2.1	2.7	3.5	4.1	4.7

For the benefit of those who wish to use meters and a different standard value, Table 6 has been prepared, giving the computed velocities in fathoms and meters corresponding to the percentage corrections in Tables 1 to 4.

TABLE 6

Depth		Table 1		Table 2		Table 3		Table 4	
Fathoms	Meters	Fathoms	Meters	Fathoms	Meters	Fathoms	Meters	Fathoms	Meters
600	1,097	799	1,461	805	1,472	815	1,492	799	1,461
1,200	2,194	804	1,471	808	1,478	813	1,488	801	1,465
1,800	3,292	809	1,479	812	1,485	815	1,492	806	1,474
2,400	4,389	815	1,491	815	1,492	820	1,500	812	1,485
3,000	5,486	820	1,499	821	1,501	824	1,507	817	1,494
3,600	6,584	826	1,511	826	1,511	828	1,515	822	1,504
4,200	7,681	831	1,519	833	1,522	833	1,524	828	1,515
4,800	8,778	836	1,529	837	1,530	839	1,534	833	1,522
5,400	9,875	841	1,537	842	1,539	844	1,542	838	1,532

Salinities used: 34 was used from 30° N. to 40° S., except 33 at 20° N. from 160° to 130° W., and at 10° N. from 140° to 120° W. For all other areas, salinity 33 was adopted. Error introduced by this practice is small.

To show that the error involved in using the tables for the large regions adopted is not great, Table 7 was prepared. The equatorial region is selected as it has a greater range than the others. The reason that the departure from the mean is different for the maximum and minimum is that a much smaller region is affected by the minimum. The departure from the mean is much smaller than the extreme values given for all but a small part of the total area.

TABLE 7

Depth in fathoms	Velocity: Maximum	Velocity: Minimum	Percentage of correction: Maximum	Percentage of correction: Minimum	Percentage of correction: Adopted	Maximum difference from adopted value: Per cent.	Maximum difference from adopted value: Fathoms
600	819	809	2.4	1.1	2.0	0.9	5
1,200	816	811	2.0	1.4	1.7	0.3	4
1,800	817	814	2.1	1.7	2.0	0.3	5
2,400	821	818	2.6	2.3	2.5	0.2	5
3,000	825	823	3.1	2.9	3.0	0.1	3
3,600	830	828	3.7	3.5	3.6	0.1	4
4,200	835	833	4.4	4.1	4.2	0.2	8
4,800	839	838	4.9	4.8	4.9	0.1	5
5,400	844	841	5.5	5.1	5.4	0.3	16

As a test of this method, twenty-two soundings in the Pacific shown on page 22, Special Publication No. 108, were computed, using Table 5, and the results compared with those based on observed temperatures and salinities. The soundings ranged from 736 to 3,472 fathoms. The greatest difference was six fathoms and the average difference for the twenty-two, 2.5 fathoms without regard to sign. In six cases there was exact agreement.

N. H. HECK
JERRY H. SERVICE
UNITED STATES COAST AND GEODETIC SURVEY

THE IMPORTANCE OF MINUTE CHEMICAL CONSTITUENTS (INFINIMENT PETITS CHIMIQUES[1]) OF BIOLOGICAL PRODUCTS: NICKEL, COBALT AND INSULIN[2]

AT the end of the last century it was considered that plants and animals were composed of an association, under different forms more or less complicated, of about a dozen elements—carbon, hydrogen, oxygen, nitrogen, sulfur, phosphorus, chlorine, potassium, sodium, calcium, magnesium and iron.

Later, due to refinements of analytical chemistry, about an equal number of other elements were found in the organs of living species of plants and animals. Consequently, there may now be added to the above list silicon, boron, titanium, arsenic, iodine, bromine, fluorine, manganese, aluminium, zinc, copper, nickel and cobalt.

The proportion of the various elements which enter into the composition of an organism differs greatly according to whether they belong to the first list or to the second. Those of the former, aside from iron, are very much more abundant than those of the latter list, and make up more than 99.9 per cent. of the total weight of the substance, while iron and the elements of the second list make up the balance. That is to say, there are present only extremely small proportions of these latter elements.

The first eleven elements exercise an essentially plastic rôle in that they enter into the composition of the protoplasm, the nucleus and the cell walls, the reserve materials, the internal or external skeleton, the dissolved substances which maintain the rigidity of soft tissues, etc. Their utility is apparent at the first examination.

This is not the case with the other elements. On account of the very small quantities present, they can not, *a priori,* play the rôle of plastic elements, and the idea has been frequently expressed that they are of no physiological interest. Numerous and very careful experiments during the last dozen years have shown, on the contrary, that certain of these elements play a very important part as catalyzers of metabolism.

In 1912 I had the honor of presenting a paper at the Congress of Applied Chemistry held at New York,[3] in which this conception was developed, especially from the point of view of agriculture. I described my personal researches in which the intervention of manganese in the catalytic oxidation provoked by laccase was shown, and, furthermore, that manganese must be included among the elements necessary for vegetable growth. An application of these experiments has been the employment of manganese as a fertilizer.

Addressing myself to-day to a group particularly interested in questions of therapeutic chemistry, I wish to present the recent work which I have undertaken with some of my collaborators upon the importance of nickel and of cobalt in biology.

Following the discovery with M. Mokragnatz in 1922 of the presence of small quantities of nickel and of cobalt in all samples of arable soil which were examined,[4] we sought to ascertain whether these two

[1] The expression "infiniment petits chimiques" has a definite sense in French which can not be exactly translated into English. "Infiniment petits" was adopted by Pasteur and his associates to indicate microbes which were infinitely small living organisms responsible for profound changes. M. Bertrand by the modification "chimique" limits the application of the term to those chemical elements or complexes which, in extremely minute amounts, are responsible for a great variety of reactions occurring in biochemical systems.

[2] Address delivered by the director of the Biological Chemical Laboratory of the Pasteur Institute, of Paris, at the meeting of the American Chemical Society, on September 9, 1926.

[3] Transactions Eighth International Congress of Applied Chemistry, Vol. XXVIII, p. 30.

[4] Bull. Soc. Chim. de France, [4] *31,* 1330 (1922); *37,* 326 (1925).

metals were absorbed and retained by plants. The experiments demonstrated that this was the case.[5] Later, in collaboration with M. Macheboeuf, the study has been extended to the animal kingdom and it has been found that the bodies of man and of a great variety of animals contain very small quantities of cobalt and of nickel.[6] The amount present is of the order of a fraction of a milligram per kilogram of the fresh tissue.

Is the presence of these two metals in the organism purely passive, resulting from the gradual passing of nickel and cobalt from the soil to the plants and then to the animals by the agency of the ordinary laws of physical chemistry; or is it, on the contrary, due to the intervention of one or many biological processes? Upon first consideration it might be expected that a very long time would be necessary for solving this difficult problem. However, we have been fortunate in discovering a series of facts which, although they may not furnish a complete solution of the problem, already indicate the importance of nickel and cobalt from the biological and even the therapeutic point of view.

In determining the distribution of these two new elements of living material in various organs, we have been impressed by the relatively high content of these metals in the pancreas.[7]

We have therefore undertaken to demonstrate whether there is a relation between the two metals and the physiological action of this gland.

We have found in working along this line that insulin preparations contain considerable amounts of nickel and cobalt. On the basis of equal weights of sample, there are often hundreds of times more of these metals in insulin than contained in the tissues from which it was extracted.

Considering these results in comparison with the rôle played by manganese in the action of laccase, we have sought to learn whether nickel and cobalt intervene in some manner in the hypoglycemic action of insulin.

The experiments have shown that with certain preparations of insulin the simultaneous injection of a small quantity of nickel or of cobalt increases notably the quantity of sugar destroyed. We have made experiments upon rabbits[8] and dogs[9] and found in both cases an activation of the hypoglycemic power of the insulin.

[5] Bull. Soc. Chim. de France, [4] *37*, 554 (1925).

[6] Bull. Soc. Chim. de France, [4] *37*, 934 (1925); *39*, 942 (1926).

[7] Compt. rendus *182*, 1305 (1925).

[8] Comptes rendus *182*, 1504 (1926).

[9] Comptes rendus *183*, 5 (1926).

Should one on the basis of these experiments consider nickel and cobalt as the coferments of insulin in the same way that manganese is the coferment of laccase? Do they form a part of the molecule of insulin? Furthermore, are there two substances in insulin, or rather in the preparation of insulin, of which one depends upon the action of nickel and the other upon that of cobalt?

In order to reply to the first of these questions it is necessary to cause insulin to act *in vitro*, which has not as yet been done. It is possible that nickel and cobalt do not intervene in a direct manner in glycemia, but by the intermediary of a particular organ.

As for the other questions, they can probably be easily answered by means of experiments with pure insulin such as has recently been obtained in a crystalline state by Professor Abel.

Personally I shall not be surprised if a metal is not found as a constituent of the insulin molecule. It is possible that in the present case the phenomenon is analogous to that of the transformation of protrypsin into trypsin under the influence of calcium, and thus there is in the pancreas, and consequently in certain preparations prepared from it, one or two kinds of pro-insulin of which the transformation into insulin is conditioned by the presence of nickel or of cobalt.

An application may, however, be made of the facts which have been observed. It is the possibility of advantageously modifying certain preparations of insulin by the addition of suitable amounts of nickel or of cobalt.

But this is not the only application.

Since diabetes, or, more particularly, certain forms of diabetes, are the result of an anatomical or perhaps simply functional alteration of the pancreas, it is not illogical to examine whether it may not be possible to cure or at least alleviate certain cases of the disease by the introduction into the general circulation of small quantities of nickel or of cobalt.

M. Macheboeuf and I have begun such experiments, first with nickel or cobalt alone, and then with mixtures of the two. Encouraging results have been obtained. We have found,[10] and our observations have been confirmed by those of M. Rathery and of Mlle. Levina,[11] that cases of simple diabetes, excluding the consumptive type, may be benefited, sometimes even to the extent of the complete suppression of urinary sugar.

There is here a new and indeed unexpected application of the study, so full of promise, of the rôle of the "infiniment petits chimiques" in biology.

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[10] Comptes rendus *183*, 257 (1926).

[11] Comptes rendus *183*, 326 (1926).